FIFTY · LESSONS · IN WOODWORKING: UPHAM

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IN

WOOD WORKING.

BY

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FIFTY LESSONS IN WOOD WORKING.

PREFACE.

It is not assumed that the following is the best possible course in manual training. According to G. Stanley Hall, "There are always several equally good ways, and the best probably has not yet been discovered."

Possibly ten years will show as great change in the method of instruction in manual training as it has in the teaching of drawing.

This course is the one the writer has employed, and the results seem to warrant its presentation to others in the hope that it may aid those who desire to enter the field, even partially, as instructors.

Two classes of people advocate manual training,—one class solely for the mental discipline gained, the other for the manual dexterity acquired. The first class claim that the object of the public schools is to train the mental powers of the pupil; that the home, the shop, and the place of business must be relied on to teach the application of this knowledge. The second class believe that not only the mental powers should be trained, but the physical ability to apply these powers should be acquired. As the pupil, after being taught the rules of arithmetic, is set to

measure a room or a pile of wood, so having conceived some construction he is set to make it in wood or metal.

It is usual to hear the objections: "Why should the school be burdened to teach the boy to drive nails, to saw boards, and do other mechanical tasks?" For two reasons. First, because every one, rich and poor, high and low, is constantly in need of a little manual dexterity: from the time a man buttons his collar in the morning till he fastens his door or window at night, he is called upon to perform mechanical operations. Second, because of the disappearance from the household of numerous operations once performed there, and that gave manual training, as stitching shoes, braiding hats, plaiting straw, seating chairs, making mats, etc. The introduction of machinery has taken these operations out of the household; the shops have "No Admittance" written over their doors.

Hence if a youth is to have manual training he must get it through the schools.

It is the purpose of this little manual to outline a course such as is possible in a school for both boys and girls of fourteen years of age or upwards,—to furnish a sort of shorter course in manual training. Forty-five minutes a day, are to be devoted to the work. This is all the time that can be spared usually; and in fact that is enough if properly employed, especially for girls,—and I wish to insist that girls as well as boys should take the course.

A. A. U.

Whitewater, Wis., 1892.

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PRACTICAL SUGGESTIONS.

EACH pupil should have a book, and study the exercise carefully beforehand.

In every case he should make a working drawing, showing different views of the object he proposes to make. These drawings may be full-size, half-size, quarter-size, etc., as the teacher may direct. He should work with the book before him, following the directions step by step. The mental discipline gained by working from printed directions is by no means to be despised.

The article when done should be compared with the working drawing.

The name of the maker and the date of construction should be written on each article.

The material, in general, should be first-class pine, undressed, $\frac{1}{2}''$, $1''$, $1\frac{1}{8}''$, $1\frac{1}{2}''$ thick, 20 to 30 feet of each size being bought at first. This is better than dressed lumber, because the pupil has practice in "getting out his stuff." When the pupil has acquired skill in planing and begins to make articles of use, dressed lumber may be used.

The tests should be applied by the pupil as far as he is

able, and the aim should be to make him competent as soon as possible.

It is well to "mark" each pupil's work on a scale of ten, for in this way the pupil will the more readily realize how he has succeeded in his work.

If public exercises are given as in some schools, the work should be exhibited the same as other school-work. It must be borne in mind that pupils vary much in their ability to execute work of this kind. The teacher must guard against a tendency on his part to take hold of the work and do it for the pupil. If he finds it is not enough simply to tell the pupil, he may show the pupil by taking another piece, and proceed to dig out a mortise or make a tenon, etc. The pupil will then take up his work and do as he has seen the teacher do. Again, in showing a pupil how to set a gauge or a plane, after he comprehends the directions the gauge should be changed and the plane moved out of adjustment, and the pupil required to adjust them properly.

LESSONS IN WOOD-WORKING.

Chapter I.

USE OF TRY-SQUARE, GAUGE, HAMMER, SAW, PLANE, BIT, AND CHISEL.

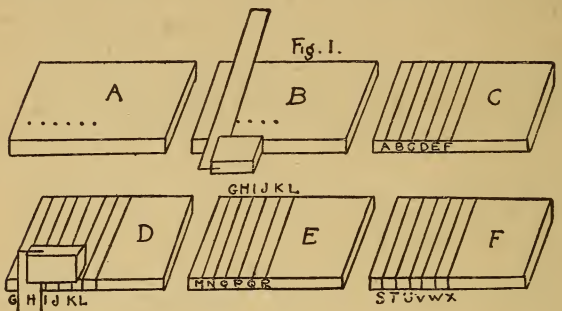
Lesson I.—To mark around a piece with a try-square.

Material.—A piece of pine about 1′ long, 1″ × 2″ or ½″ × 1″. The material for this lesson may be taken from the "waste heap" or waste pieces of flat moulding from a carpenter's shop; or window-parting ½″ × 1″ may be bought. The sides must be accurately parallel; sides and edges smooth.

Working Drawing.—*A* represents the piece selected, with pencil-dots at equal distance; *B*, *C*, *D*, *E*, *F*, represent other stages in the process.

Directions.—Lay a rule or square upon the flat side parallel to one edge and with a sharp pencil make a dot at each half of an inch, thus: . Make six dots (see Fig. 1, *A*). With a try-square (see *B*) and a sharp pencil draw six lines across the face, placing the head of the square firmly against the edge of the board. The work will appear as

seen at *C*. From the ends of the lines *a, b, c, d, e, f,* still using the try-square, draw the short lines across the front edge of the board *ag, bh, ci, dj, ek, fl*. The work will appear



as in *D*. Turn over the board and from the points *g, h, i, j, k, l* draw the lines *gm, hn, io, jp, kg, lr,* using the try-square (see Fig. 1, *E*). Turn the board over, still using the try-square, and draw the lines *ms, nt, ou, pv, qw, rx* down the fourth side.

Test.—If upon drawing the lines down the fourth side *ms, nt,* etc., they exactly meet the ends of the lines made on the first side, the work has been well done.

SECOND EXERCISE.—Lay off lines in the same way at each quarter of an inch the whole length of the piece, and proceed as above. Do this several times until skill has been acquired.

Test.—The test given above applies here. The teacher may plane off the faces of the piece for each successive trial.

LESSON II.—To mark with a gauge.

Material.—Pieces of the same size as employed in Lesson I will do here.

Directions.—(1) Set the spur of the gauge (Appendix, p. 15) $\frac{1}{8}''$ from the head and draw it along one side of the piece, over the end, down the other side, and across the other end.

(2) Mark each of the four sides of the piece in a similar way.

(3) Then set the spur at $\frac{1}{4}''$ and repeat.

(4) Set the gauge at $\frac{1}{2}''$ and repeat, and so on until the piece is covered with marks.

(5) Then plane off the marks (or take another piece) and set the spur so that it reaches within $\frac{1}{8}''$ of the further sides of the broad face, and mark as before two lines on each broad face and across the ends.

(6) Set the gauge $\frac{1}{8}''$ narrower and continue until marks already drawn are reached.

This practice must be continued until lines can be drawn lightly and perfectly parallel with the side of the piece. No tool seems to be so difficult to handle skilfully, and no tool is more important for the production of good work.

Tests.—Are the lines light, without break; of even depth? Are they parallel?

LESSON III.—To drive nails.

Material.—A piece 1′ long, 1″ thick, and 6″ wide (any other size will, however, do as well). Wire nails $1\frac{1}{8}''$ long. Draw lines $\frac{1}{2}''$ apart with try-square on the broad faces, across the grain, and across one narrow edge; also mark with a gauge along the grain on both broad sides lines $\frac{1}{2}''$ apart. Lay the piece down over a piece of waste material, and, beginning at the left-hand end, drive a row of nails in at each point of intersection of the lines.

Test.—As soon as this row is filled, pull the boards

apart and see if the nails come through where the lines intersect on the other side.

Move the piece along so that the nails already in will just project over the end of the waste, and drive nails in the second row (the ends will enter the waste as in the first row).

Test.—Pull off the waste and see if the nails have come out at the intersection. After the nails are all in, turn the piece over and drive them back one row at a time and draw them with a claw-hammer (Appendix 11).

LESSON IV.—To saw to line along the grain.

Material.—A piece 3″ long, 6″ wide, and 1″ thick.

Working Drawing.—(To be made by the pupil.)

Directions.—With the try-square and sharp pencil mark lines in the direction of the grain $\frac{1}{4}$″ apart the whole width of the piece and across one end. Also draw a line around the piece $1\frac{1}{2}$″ from one end. Fasten the piece upright in the vise with about 2″ projecting. With a back-saw (Appendix 5) cut down on each line, stopping exactly at the cross-mark on each side of the piece.

This exercise may be varied by marking the piece in quarters of an inch on two sides and then drawing the lines obliquely across the end, from the first mark on one side to the second mark on the other side, and sawing down as before.

Test.—The saw must exactly follow the marks.

In this connection let the pupil lay off and saw pieces $2\frac{1}{8}$″ wide from the edge of a board 8′ long, $1\frac{1}{8}$″ thick, and cut into one-foot lengths for future use, using the large rip-saw for this purpose.

Test.—The pieces must be of exactly the same length and width.

LESSON V.—To plane a piece to a certain thickness.

Material.—One of the 1′ pieces made in the last lesson.

Directions.—Gauge lines on the narrow sides and ends, $\frac{3}{4}''$ from the flat face, and with a jack-plane remove the surface until the piece is $\frac{3}{4}''$ thick (Appendix 10). Plane one of the thin edges, and from this gauge lines on the broad sides $1\frac{3}{4}''$ from the planed edge. Plane down to this line. Again gauge from the broad side $\frac{1}{16}''$ less than the thickness, and remove with the smoothing-plane.

(It may be well now to practise on the edges of the piece with a moulding-plane if you have one, or a rabbit-plane, until the piece is too small for further use.

Test.—In planing for a smooth surface, test by laying the plane across the piece, turning the sole of the plane on the edge: the surface should be level and smooth.

LESSON VI.—To plane a $2'' \times 1''$ piece $12''$ long with square corners.

Material.—One of the pieces from Lesson IV.

Working Drawing.—The pupil will make a plan of the work he proposes to do, full size or one-half size, and show it to the teacher before he begins. On the approval of his working drawing he may begin. His work must strictly conform to this drawing. A plan of the work required is given below, see Fig. 2. *A* represents the top, *B* the front, and *C* the end.

Directions.—(1) Plane one broad side for the working face, and mark it with an *x*.

(2) Now gauge from this face, with the spur one inch

from the head, on each of the narrow sides, and plane to the middle of the gauge-marks.

(3) Plane one of the narrow sides square with the working face, and mark the adjacent sides.

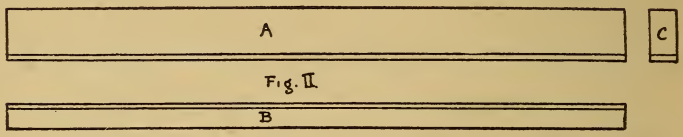


Fig. II.

(4) Set the gauge at 2″, and gauge on the broad faces for the last side.

(5) Cut the piece 12″ long.

Tests.—If the work has been carefully done the corners will all be square, the surfaces, ends, and edges smooth and straight. Hence these questions will be in the mind of the teacher: Are the corners square? Is each surface smooth? Are the sides straight? Are there breaks in the edges? Are the ends cut square? An examination of these points will enable the teacher to mark the work on a scale of 10. The pupil should continue to work at this problem until he can produce a handsome piece of work before he proceeds further.

LESSON VII.—To saw to line across the grain.

Material.—The pieces made in the last exercise, or one like it, 1″ × 2″ × 12″.

Working Drawing.—(This may be made by the pupil.)

Directions.—With a try-square mark the piece one-half inch from the right-hand end; also mark at intervals of a half-inch the whole length of the piece. Hold the piece with the right end projecting from a vise, or hold it on the bench-hook as directed (see *A*, Fig. 50). Attention

should be given to the mark on top and front edge till the saw strikes the back edge, and then give attention to the mark on the top of the work. To *test,* place a try-square against the ends, and hold the stick up between the eye and the light.

Proceed to saw, and test until the whole piece is sawed away.

Tests.—Is the end square in every possible way? Did the ends of the lines coincide? Did the saw run exactly on the mark, or just at one side, as was desired? (The line should not be sawed away.) Is the end smooth?

LESSON VIII.—To bore holes accurately.

Material.—Two pieces like those produced in Lesson 6.

Working Drawing.—(To be made by the pupil.)

Directions.—(1) Mark the first piece on the broad faces $\frac{1}{2}''$ from the edges, using the gauge set at $\frac{1}{2}''$ to mark the lines parallel to the edges of the pieces. (2) Mark the second piece with the gauge so as to divide the thin edges exactly in the middle; then mark across each piece on four sides, with try-square, with lines one inch apart. If the pieces have been accurately planed and marked the intersections of lines on opposite sides will be exactly in the same planes. (3) Bore holes with a half-inch bit in the first piece at the intersection of lines down through the broad faces, and in the second piece down through the narrow face. There will be 22 holes in the first set and 11 in the second. The aim should be to have the spur of the bit come out at the intersection of the lines on the back side of the pieces. Hold the pieces in the vise so that the hole to be bored will be just about on a level with the bit. Hold the head of the bit-stock in the palm of the left hand,

the fingers grasping it and the back of the hand, or rather the outside of the hand, against the bit, which then presses against the bit-stock. Have the left foot point under the bench and the right towards the foot of the bench. Stand bracing and turn the stock with the right hand (clockwise). In order that the bit may not splinter on the back side of the piece, have a piece of waste board behind into which the bit will bore a short distance. To remove the bit turn back about two turns, then pull on the bit-stock and turn in the forward direction, and it will come out, removing the shavings with it.

It may take a good many trials to do this work well, and it may be varied by screwing the work in the vise so that the working face is uppermost, holding the bit and stock vertically, the left hand being steadied by the elbow held against the left side. It is sometimes necessary to hold the work in the vise this way in order to prevent splitting when a piece is bored.

Tests.—Are the holes bored straight through? Are the holes smooth? Is the back side not splintered?

When the $\frac{1}{2}''$ bit is mastered other sizes may be used.

LESSON IX.—To smooth a surface with a chisel—with the grain, across the grain.

Material.—A piece 1′ long split out of a 2″ plank with a hatchet or chisel.

Working Plan.—Make a drawing of the top *A*, front *B*, and end *C* of the piece as it will be when completed; draw lines to show how it may be tested. (See Fig. 3.)

Directions.—(1) Screw the piece into the vise with a rough side projecting $\frac{1}{2}''$ above the jaws. Use the chisel with the bevel side down until the piece is fairly smooth, then

turn the chisel over and work the piece until it is smooth. Use a ruler or blade of the square to test the work to see that it is straight and smooth. If available, take two pieces a foot long and an inch or so wide and lay them across each

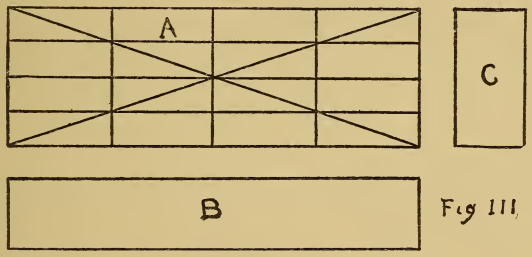


Fig 111

end of the piece as it is held in the vise. Squint across them, and any winding in the surface will be easily seen.

Tests.—Test in three places across and in three places along the grain, and twice on the diagonal. (See Fig. 3.)

Is the surface smooth?

Is the surface straight?

Is it free of chisel marks?

(2) Saw a short (2″) piece from the end of a plank 6 inches wide, and smooth the surface, working across the grain.

Tests.—The same as above.

LESSON X.—To smooth the end of a piece with a block plane.

Material.—The short piece used in the last exercise.

Directions.—Mark with try-square $\frac{1}{16}$″ below the end, all around. Screw the piece firmly into the vise, and have the block plane very sharp and set firm. Begin at one edge and work towards the middle, turning the piece around so

as to keep the surface as even as possible. Move the plane straight across the piece the longest way, but turn the plane so that the chisel cuts with a drawing stroke. Avoid planing *over* the further edge of the block.

Make about the same kind of motion as is made in washing clothes on a washboard.

Tests.—Is the surface smooth and straight; especially, are the corners still present, or have they been split off?

LESSON XI.—To square a piece with a chisel.

Material.—A piece $6'' \times 2\frac{1}{8}'' \times 1\frac{1}{8}''$

Working Plan.—Let the pupil make a drawing of the work, as in Lesson 6.

Directions.—Screw the piece into the vise with the smoothest face up and projecting $\frac{1}{2}''$ above the jaws of the vise. If the surface is very rough, use the chisel first with the bevel side down, holding the handle in the right hand and the blade with the left. After the piece is fairly smooth, turn over the chisel, working neither across nor with the grain, but half-way between. (See Fig. 52.)

Test with the edge of the blade of the try-square, and work until the piece is perfectly flat; then mark it with a cross (×); (this indicates that it is selected for the *working face.*) In the same way work off a side adjacent to the working face, testing to see that it is square with it.

Now take the gauge and set it so that when the head is against the "working face" the spur will just extend to the opposite side, where the stick is thinnest. Mark the two sides *e, e.* Cut down to the *middle* of the line made by the spur, and test all around to see if it is square. Make all corrections on the third and fourth sides. Avoid leaving marks made by the corners of the chisel. Avoid

cutting a thick shaving over he edge so that it will split off.

Tests. — Are the corners square? Is each surface smooth? Are the sides straight? Are there breaks in the edges? Are the ends square?

The pupil should keep at this problem until he produces handsome pieces of work,—work that will be marked 10 by his teacher,—before he proceeds further.

Chapter IX.

LESSONS XII TO XVIII, INCLUSIVE.

OPERATIONS ON WOOD.—OF RABBETS, OCTAGONS, CYLINDERS, ETC.

LESSON XII.—To cut six rabbets in a piece $12\frac{1}{2}'' \times 2'' \times 1''$

Material.—The piece made in Lesson VI.

Working Drawing.—*A* gives a front, *B* a top, *C* an end view. (See Fig. 4.)

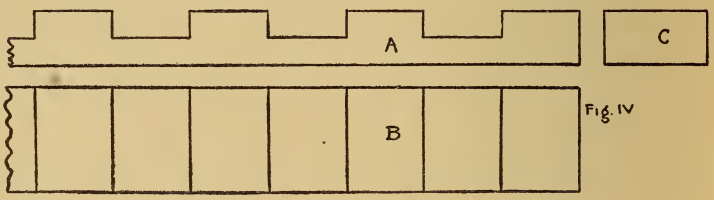


Fig. IV

Directions.—Mark with the gauge on the two narrow sides and ends $\frac{1}{2}''$ from the edge. Then mark with a try-square on the broad side and down to the gauge-marks on the narrow sides; have these marks $1\frac{1}{4}''$ apart, and mark every other one with a cross (×). These are the parts to be removed.

With a fine back-saw cut down inside the marks so as to have the "saw kerf" come in the pieces that are to be re-

moved. Fasten the pieces in a vise, and with a 1″ chisel work out the parts to be wasted. Use chisel on both sides of the piece; bevel the side down until the work is nearly finished, then turn the chisel over and trim to the line, with the flat side down.

It may then be sawed across the middle and tested by trying to fit the projections into the depressions. This work should be repeated until the halves will go together, and the joints be fairly even and alike.

Tests.—Are the rabbets of exactly equal width? Are they of exactly equal depth, and just to the gauge-mark? Were the saw-cuts straight? Did the saw stop when the gauge-marks were reached? Are the bottoms of the rabbets smooth? Are the saw-cuts smooth? Are the corners all whole? Do the parts fit well together?

LESSON XIII.—To cut rabbets across a piece obliquely.

Material.—The same as before.

Working Drawing.—*A* gives a top view of the work. (See Fig. 5.)

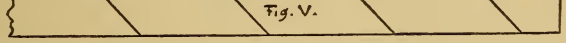


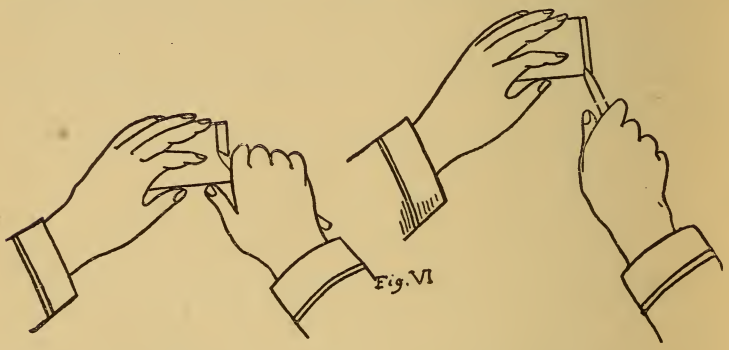
Fig. V.

Directions.—Lay off on one edge points $\frac{3}{4}$″ from one end, and at successive distances of $1\frac{1}{4}$″. Set the T bevel so that the blade touches the first point and the opposite corner, and draw lines across from each point. Gauge the narrow sides through the middle, and with a try-square lay off lines from the ends of the lines on the upper face to the gauge-marks. Work out the rabbets as before, and apply the same tests.

LESSON XIV.—To divide a thin piece with a knife, (1) across the grain, (2) with the grain.

Material.—A thin piece $\frac{1}{8}''$ thick sawed from the broad face of one of the pieces from Lesson IV. The piece may be sawed held upright in a vise. Have the part upon which the saw is operating down near the top of the jaws, and move it up several times as the work proceeds.

Directions.—(1) To cut across the grain: Mark all around with a try-square $\frac{1}{2}''$ from one end. Lay the piece on the bench with one edge parallel with the front of the bench, and place the try-square on the mark. Draw the knife lightly along the line several times, and then turn the knife to an angle of about 45°, and, removing it a short distance from the line, draw it along, cutting out a chip as shown in Fig. 6. Turn the piece over and repeat on the



other side until the piece is cut off. In cutting, draw the knife towards you, and in making the oblique cut place the right thumb in front of the piece until the knife nearly reaches the front edge, and then take the thumb away to avoid being cut.

Test.—Is the end square in both directions? Repeat, cutting off successive pieces $\frac{1}{2}''$ long until the piece is too short for further use.

(2) To divide a thin piece *with* the grain, mark on both sides and draw the knife along the blade of a square very carefully and lightly at first, then increasing in force until the piece splits off.

Soft wood $\frac{1}{2}''$ thick may be split in this way without the waste incident to sawing.

Test.—As above.

LESSON XV.—To whittle a piece square.

Material.—Split out a piece 6″ long and about $1\frac{1}{4}''$ square.

Smooth one side of the piece, using the large blade of a knife, and testing the work as directed in Lesson IX. Get another side square with this one, and then mark with a gauge to make 1″ square as in Lesson VI, and smooth to the lines, testing as in Lesson VI. Cut off the ends squarely, marking first with a try-square. After it is finished with the knife, lay the piece on a sheet of sand-paper tacked on to a board, and rub the piece until the sides are smooth. Remember never to put an edged tool on to a piece of wood after it has been sand-papered, for the embedded sand will dull the tool.

LESSON XVI.—To whittle an octagonal prism 6″ long.

Working Plan.—*A* exhibit a side and *B* an end view of the work. (See Fig. 7).

Material.—A piece like that produced in Lesson XV.

Directions.—Saw the ends square. Draw the diagonals across each end. Set the gauge equal to one half the diagonal, and draw two lines with the gauge so set along each

face. Connect across the ends the points adjacent to each other, as shown in the end view (Fig. 7). Carefully whittle off the corners down to the lines.

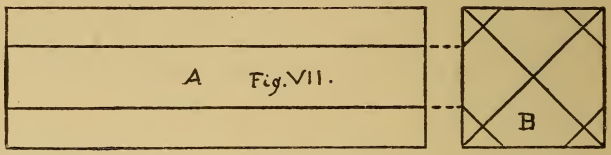


Fig. VII.

Tests.—Are the sides all smooth and straight? Are the sides of equal size? Are the sides of equal width throughout?

LESSON XVII.—To whittle a cylinder.

Material.—An octagonal prism like that produced in Lesson XVI.

Directions.—Carefully remove with the knife each corner of the octagon until the piece has sixteen equal sides; then remove each of these corners. Hold the knife at all times so that the length of the blade is at right angles to a radius of cylinder that is to be.

To complete the work, fasten the piece upright in the vise, with about half its length projecting. Cut a piece of No. 1 sand-paper about $1\frac{1}{2}''$ wide, and the whole length of the strip. Take one end of the sand-paper in either hand, and draw it around the stick with considerable pressure. Keep moving the stick up and down and around so that all sides will be acted upon by the sand-paper, and it will be found to be a pretty good cylinder.

Small cylinders like arrows and joints of fishing-rods are sand-papered by rolling them on the bench with the right hand, while the left applies the sand-paper to the part projecting over the edge of the bench.

Practice will enable one to plane and sand-paper out cylinders of all sizes without marking the ends of small ones.

Always make a square first, then an eight- and then a sixteen-sided piece, otherwise the solid is likely to be elliptical in outline of cross-section.

Tests.—Is the piece straight? Are the ends circular and equal in size? Is it uniform in size and shape?

LESSON XVIII.—To plane a cylinder.

Material.—A piece sawed or split out a little more than 1″ square and 1′ long.

Directions.—Saw off the ends square, and proceed as in making a cylinder with a knife. First make a square prism, then an octagon, then a sixteen-sided piece; take off the corners of this, and sand-paper as before. In planing for the octagon, hold the square prism by the corners in the vise. For the rest of the work it may be held in the vise or against the bench-hook, with the left thumb against the other end of the stick.

If held in the latter way, care must be taken not to cut the left hand with the plane.

Tests.—The same as in Lesson XVII.

Chapter XXX.

LESSONS XIX TO XXXIX.

ON JOINTS, DOVETAILS, ETC.

LESSON XIX.—To teach the making of different kinds of joints, their uses and properties.

Before starting the pupil off on the real work of making joints, it will be a good plan to give some general ideas on the different kinds of joints.

The simplest way of joining two pieces of wood together (like the two sides of a frame, for example) is to saw off the ends of both pieces square, and fasten them together with nails, the lower surface of one piece being put across the end of the other (see Fig. 8). This kind of joint is sometimes used, as in a fly-screen which has wire netting nailed over it; as this strengthens it, it may be used with such conditions.

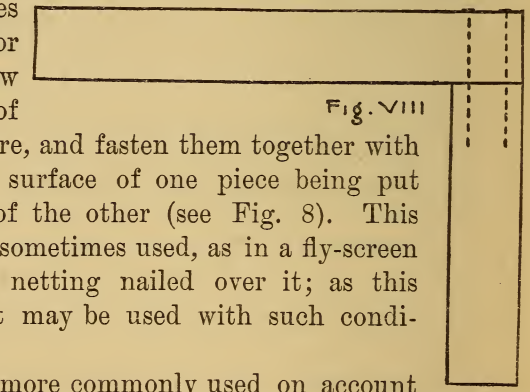


Fig. VIII

Another joint more commonly used on account of the weakness of the method just described, is called the *half* or*lap joint.* (See Fig. 15.)

To make an end half-joint the pieces must be the same

thickness, and one half the thickness of each piece is removed; the two ends thus cut are placed together and held with a nail, screw, or with glue.

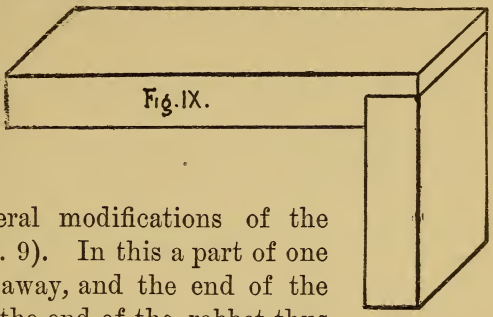


Fig. IX.

There are several modifications of the half-joint (see Fig. 9). In this a part of one piece only is cut away, and the end of the other fits up into the end of the rabbet thus made. Such a joint is often used at the corner of a box, or in building frame houses.

Another modification is the *grooved joint* (see Fig. 10).

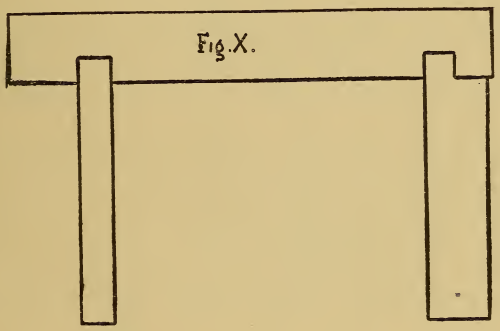
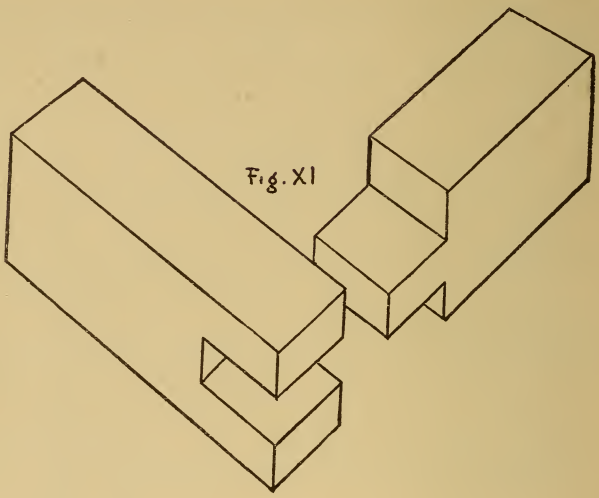


Fig. X.

This form is frequently used to fit in the bottom of a box or drawer, often modified by cutting away a part of the piece inserted, in which case it is called a dado joint. (See Fig. 10).

The *mortise-and-tenon joint* is one of the most familiar kinds of joint; there are several varieties. The most

common is the "open" (Figs. 11 and 19), "closed" (Fig. 21), and "blind" (Fig. 12). These joints are used in the



frames of doors, windows, tables, and various kinds of machinery, wagons, wheelbarrows, etc.

The process of making is the same as in the others, but greater care is necessary to cut straight into the wood, because being all worked from one side any irregularity will not be corrected. The "blind" mortise should extend as nearly through as possible; it is much used in furniture of all kinds. It is held together generally by a wooden pin, as may be seen on the blinds of any house; sometimes by a bolt, as shown in Fig. 12. (The learner should now be on the watch for these various kinds of joints and recognize them.) The modifications of mortise joints are "double

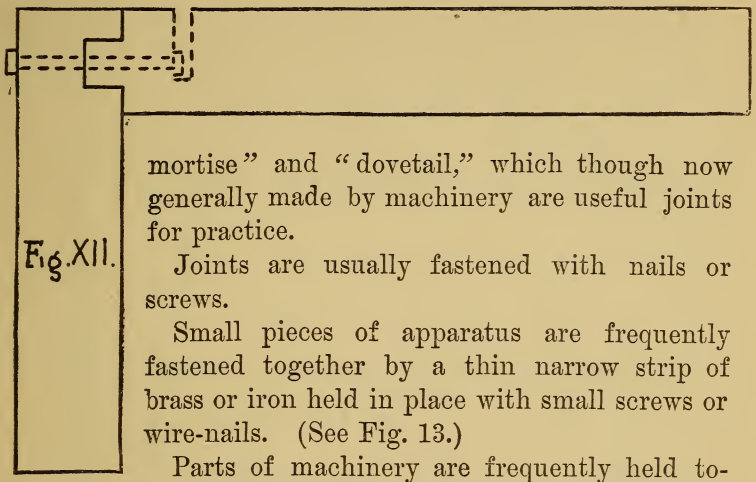


Fig. XII.

mortise" and "dovetail," which though now generally made by machinery are useful joints for practice.

Joints are usually fastened with nails or screws.

Small pieces of apparatus are frequently fastened together by a thin narrow strip of brass or iron held in place with small screws or wire-nails. (See Fig. 13.)

Parts of machinery are frequently held together with bolts extending transversely in one piece and longitudinally in the other. (See Fig. 12.)

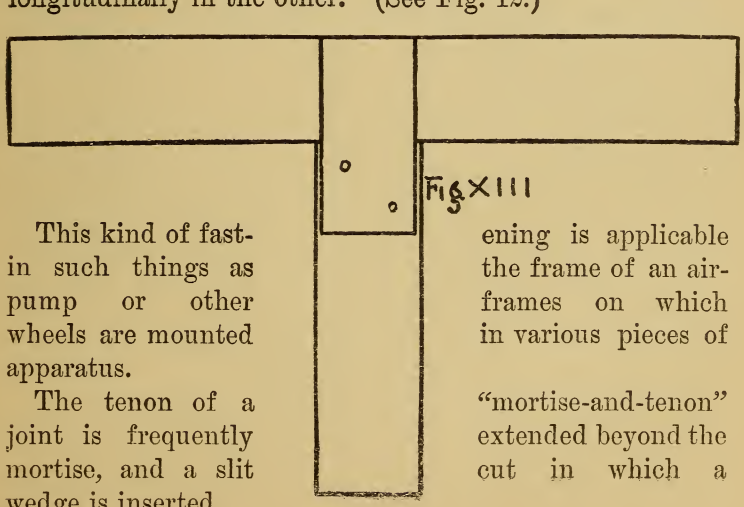


Fig. XIII

This kind of fastening is applicable in such things as the frame of an air-pump or other frames on which wheels are mounted in various pieces of apparatus.

The tenon of a "mortise-and-tenon" joint is frequently extended beyond the mortise, and a slit cut in which a wedge is inserted.

Such a joint as this is now used in the "knock-down" bookcase and other furniture, and whenever the protruding end is not objectionable. Is it a strong way of fastening, and makes a fine test exercise for the pupil. (Fig. 14.)

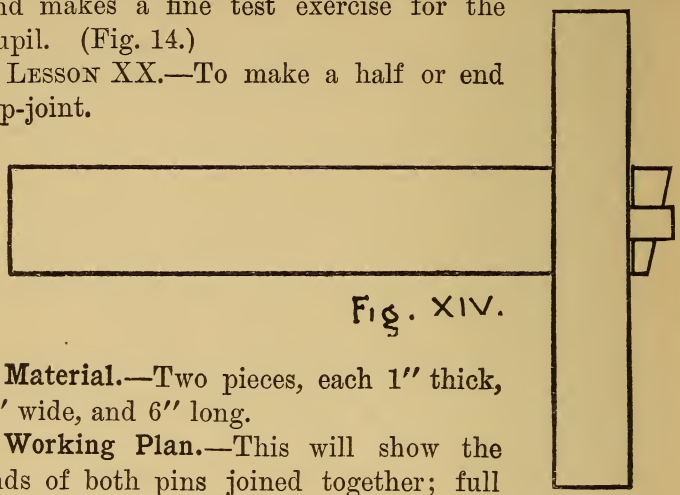


Fig. XIV.

LESSON XX.—To make a half or end lap-joint.

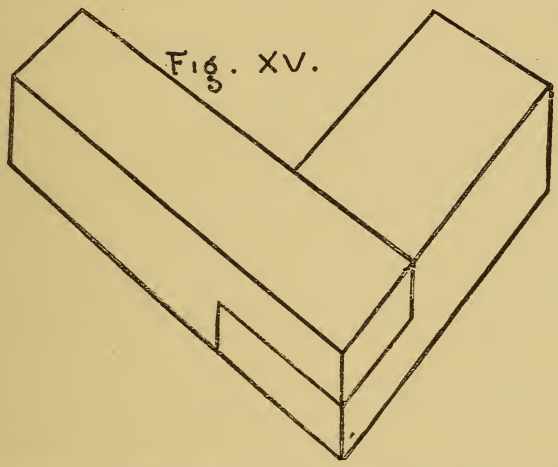
Material.—Two pieces, each 1″ thick, 2″ wide, and 6″ long.

Working Plan.—This will show the ends of both pins joined together; full size. (See Fig. 15.)

Directions.—Cut one end of each piece perfectly square. Set the gauge at ½″ and gauge the narrow sides to the extent of 2″ from one end of each piece—the square end. Also, two inches from these ends mark with a try-square across the broad side and down to the gauge marks on the narrow sides. Mark with a cross (×) on each piece that part which is to be cut away; on one piece it will be the part against which the head of the gauge rested, and on the other the opposite side. There are three ways to cut away the superfluous part: (1) pare it all away with a chisel after sawing down on the cross-marks; (2) saw down nearly to the line and pare away the little that is left; (3)

saw accurately down on both lines. These methods may be tried in the order in which they are given. Hold the work in the vise and pare carefully with a 1″ chisel as directed in Lesson II, taking off thin shavings at each cut.

It will be noticed that the spur of the gauge makes a V-shaped mark, and in making joints of all kinds care must be exercised not to pare away further than to the



middle of the mark, otherwise the pieces left will be too thin and the joint will not fit properly.

To make the joint wholly or in part with the saw, hold the piece in a vise and saw with extreme care, allowing the saw to cut only to the middle of the mark. Test the sides and shoulder of the piece with a try-square to see if they are flat and square. When the joint is properly cut out it should be held firmly in place, and one or two wire-nails driven through to hold it together. The nails should project nearly half an inch, and these projecting ends may

have a little notch filed on the sides with a three-cornered file down close to the wood, when they may be easily broken off and the ends filed smooth down to the wood.

Tests.—Are the two pieces at right angles with each other?—that is, is it square? Do the ends come just to the edge? As it is laid on a bench, does it lie flat? Is the joint smooth at both ends? Are the corners all square?

If it fails in any of these points another trial should be made until a good joint can be made.

A carpenter in making such a joint sometimes leaves the ends projecting a fourth of an inch, and saws them off flush with the sides; but, as the student is after skill, and not joints in themselves, it is better to cut the ends just right at first.

LESSON XXI.—To make a middle lap-joint.

Working Drawings.—A top view and a side view. (Fig. 16.)

Materials.—Two pieces $6'' \times 1\frac{1}{4}'' \times 1'$.

Directions.—Get out the pieces with square ends and corners. Set the gauge at $\frac{1}{2}''$ and gauge on the sides near on end of *a* a distance of $1\frac{1}{4}''$ from the end, also across the end. Gauge the piece *b* on both sides near the middle, a distance of $1\frac{1}{4}''$. Hold the head of the gauge against the top side of each piece, and mark with a X the part to be wasted.

Mark with a try-square on three sides of *a* $1\frac{1}{4}''$ from the end, across the under side, and up to the gauge-marks on the narrow edges. Mark the piece *b* to cut out a rabbet $\frac{1}{2}''$ deep and $1\frac{1}{4}''$ wide. Cut away the waste in *b* as in Lesson XII.

The waste in *a* may be removed in the same way, or the whole may be removed by two saw-cuts, one across the

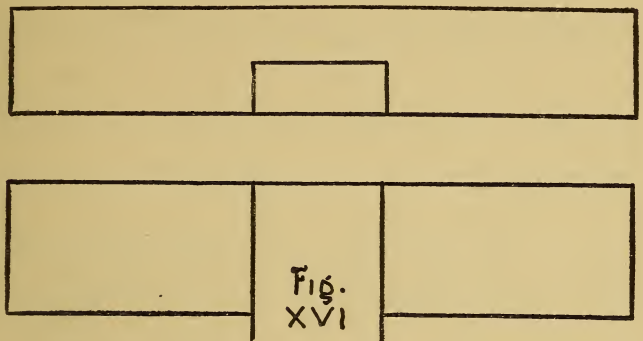


Fig. XVI

grain and one with the grain. Saw and cut in all cases only just to the *middle* of the gauge-mark. If the saw does not cut quite to the mark, pare with the chisel.

Tests. — Do the pieces meet each other perpendicularly? Is the joint close on the sides of the rabbet? Is the joint close on the under side, where the cut end of *a* comes against *b*? Is the right amount cut away so that the surfaces are even both top and bottom?

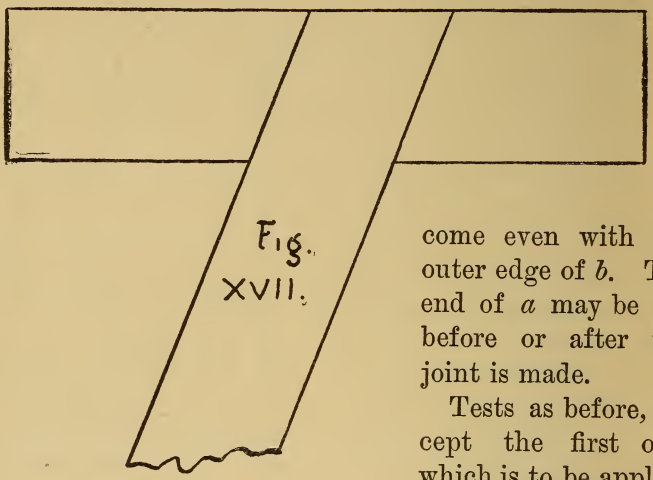
LESSON XXII.—To make a middle lap-joint at an acute angle.

Material.—The same as for the last.

Working Drawing.—A top view. (Fig. 17.)

Directions.—Mark all the lines on the broad faces with the T-bevel set at an angle of about 70°. All the lines on the narrow faces are to be marked with a try-square. The

work is to be done the same as before. Care must be taken to mark the piece *a* far enough from the end to have it



come even with the outer edge of *b*. The end of *a* may be cut before or after the joint is made.

Tests as before, except the first one, which is to be applied with the T-bevel instead of with the try-square.

LESSON XXIII.—To make a box joint.

Material.—Two pieces $\frac{1}{2}''$ thick, 3″ wide, and 6″ long.

Working Plan.—A top view. (Fig. 9.)

Directions.—One half inch from one end of one piece draw a line, using a try-square, also down on the narrow edges half-way across. With a gauge divide the narrow faces in the middle down to this line, i.e., draw lines $\frac{1}{2}''$ long and $\frac{1}{4}''$ from the broad sides. Make the cross-cuts with a back-saw and pare out with a chisel. The cross-cut is often made by means of a sharp chisel or knife drawn along beside the blade of a try-square, or even a square on a very broad piece.

In using a knife cut lightly at first until the path is

made for the knife, then draw it several times over the line, and pare away as far down as the knife has cut. Then

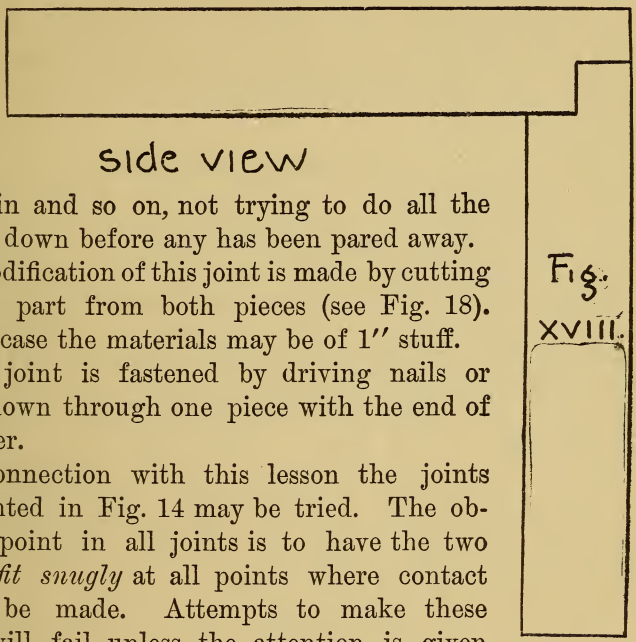


Fig. XVIII.

cut again and so on, not trying to do all the cutting down before any has been pared away.

A modification of this joint is made by cutting away a part from both pieces (see Fig. 18). In this case the materials may be of 1″ stuff.

This joint is fastened by driving nails or beads down through one piece with the end of the other.

In connection with this lesson the joints represented in Fig. 14 may be tried. The objective point in all joints is to have the two pieces *fit snugly* at all points where contact should be made. Attempts to make these joints will fail unless the attention is given to have the inserted ends perfectly square. (See directions for using block-plane.)

Tests.—As in Lesson XX.

Lesson XXIV.—To make open mortise-and-tenon joint. (Fig. 11.)

Working Drawing.—A top view, an end view. (Figs. 10 and 19.)

Material.—One piece $1\frac{1}{4}'' \times 1\frac{1}{8}''$, and 12″ long.

Directions.—Mark each end lightly with a try-square

$1\frac{1}{4}''$ from the end. Set the gauge so that one spur is $\frac{3}{8}''$ and the other $\frac{6}{8}''$ from the side, and mark on the $1\frac{1}{8}''$ side, and it will be divided into three equal parts $\frac{3}{8}''$ wide.

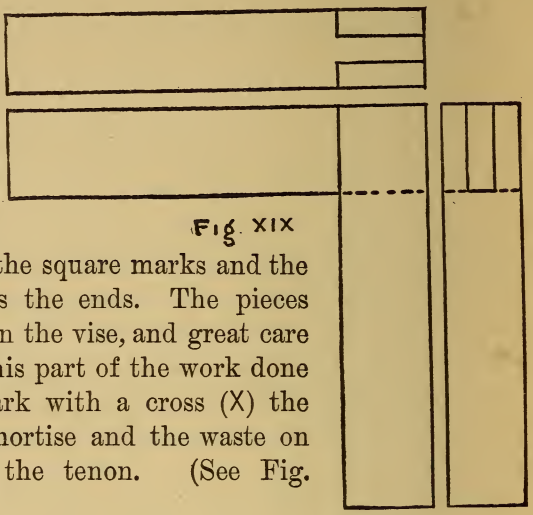


Fig. XIX

Mark between the square marks and the ends and across the ends. The pieces should be held in the vise, and great care used to have this part of the work done accurately. Mark with a cross (X) the waste for the mortise and the waste on either side of the tenon. (See Fig. 20).

Cut away the parts *b, c* on the sides of the tenon in the same way as directed for the half-joint, using the same precautions not to cut too far, etc.

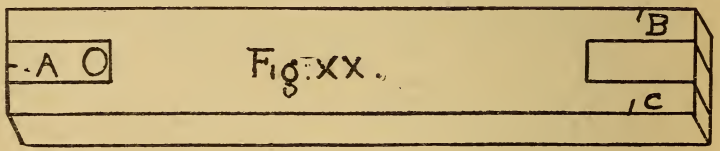


Fig. XX.

There are several methods to remove the chief part, *a*, of the waste of the mortise.

First Method.—Fasten the piece down upon the bench with a pair of clamps, or screw firmly into a vise, with the gauge-marks uppermost. With a $\frac{1}{4}''$ chisel and mallet re-

move the superfluous wood. Hold the chisel upright with the flat side out about $\frac{1}{4}''$ from the outside end of the mortise. Drive down the chisel, and the bevelled side will force out the chisel and the chips from the mortise. Repeat, moving the chisel back $\frac{1}{8}''$ until near the blind end of the mortise; then turn the piece over and remove the wood from the other side. Finish the blind end by driving the chisel half-way through from each side, having the *flat* side of the chisel in. With this method and the following it is necessary to trim the sides of the mortise to finish with a $1''$ chisel and the end with a $\frac{3}{8}''$ chisel. Test with try-square to see if ends are square and sides are flat.

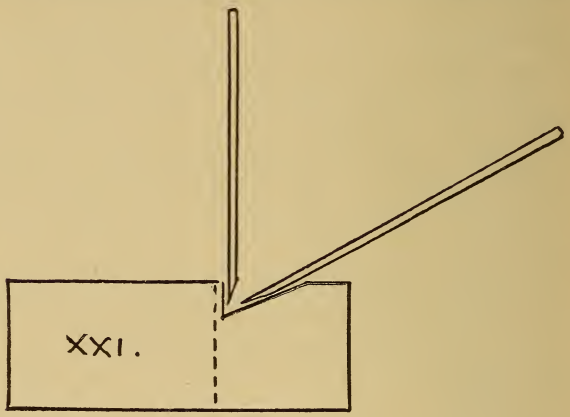
In cutting at the last at the blind end use the same precautions mentioned in using the block-plane, i.e., work towards the middle, and not over the edge.

Second Method.—Saw down with a fine saw just within the gauge-marks. With a sharp chisel cut down through the wood left by the saw. Holding the chisel upright at the blind end, drive it in an eighth of an inch; then move the chisel $\frac{1}{4}''$ nearer the end and cut out a triangular chip, the chisel slanting away from the blind end (see Fig. 21). Repeat this process till it is cut half-way through, then turn the piece over and cut away the rest.

Third Method.—Bore with a $\frac{1}{4}''$ bit a number of holes just touching each other, sufficient to take away all the superfluous wood. This is a method used for fine work in hard wood, and requires a skilful workman to bore the holes all in the same direction.

Fourth Method.—With a $\frac{1}{4}''$ bit bore one hole near the blind end. With a fine back-saw cut down as in the first

method. The fourth method is very common. It is customary when the mortise goes entirely through the piece to bore the holes part way through from one side and the rest of the way from the other. Cut the piece in two. The mortise-and-tenon must now be trimmed until the



tenon slips into the mortise with the pressure of the hand, and this joint should be practised upon till a good joint can be made. Carpenters are accustomed to leave the tenon a little longer and plane it off flush after it is in place. Examination of the joint will show that the square marks did not need to go clear a round the piece, but only on one side and opposite the waste each side of the tenon.

Tests.—Is it square? Are the ends flush? Does the tenon fill? Is the joint between the shoulder of the tenon-and-mortise good? Are the upper surfaces in the same plane?

(Sometimes one shoulder fits and the other does not, or it may even not touch. In this case it is one of the "tricks

of the trade" to cut down through to the tenon with a fine saw, after which the tenon is driven up. This is a practice much resorted to by poor and sometimes by good workmen. All such expedients are to be used only when the end sought is joints and not skill.)

LESSON XXV.—To make an open double mortise-and-tenon joint.

Working Drawing.—Top, end, and side view.

Material.—$1\frac{7}{8}''$ wide, 1′ thick, and 6″ long. Lay off with try-square one inch from each end.

Directions.—Set the gauge to mark $\frac{1}{3}$ the width of the piece, i.e., $\frac{3}{8}''$ in this case. As there are four lines to be drawn the gauge will have to be set twice. The first time the spurs will be $\frac{3}{8}''$ and $\frac{5}{8}''$ and, the second time $1\frac{1}{8}''$ and $1\frac{1}{2}''$. Lay the pieces the same way they are to go together, and be sure and mark with the head of the gauge on the same side each time. Set the gauge and mark both pieces, then set again and mark both pieces. Cut the outside of the two tenons as before, and cut the mortises by any one of the methods given. Great care will be needed in making this joint to have all the tenons fit, and this will only be accomplished by care in marking, and in cutting, as before mentioned, only to the centre of the gauge-marks. The points to be observed are the same as before.

LESSON XXVI.—To make a plain closed mortise-and-tenon joint.

Working Drawing.—A side view, end view, and view of other side of tenon-piece. (See Fig. 22*a*.)

Materials.—Two pieces $1\frac{1}{8}''$ square, 6″ long. Near the middle of the piece intended to contain the mortise mark with a try-square two lines all around $1\frac{1}{8}''$ apart.

Directions.—Set the gauge at $\frac{3}{8}''$ and $\frac{6}{8}''$, and mark between the lines on opposite sides for the mortise. Mark out the tenon, and cut it out as before directed.

There are several ways of digging out the mortise.

First Method.—The mortise may be worked out with chisel bevel side in, and mallet cutting first on one side and then on the other parallel with the grain; then with a narrow chisel bevel side in driving it straight across the grain near the end at first, then working back and finishing with the flat side near the inner end of the mortise. After cutting down at the sides and across the end $\frac{1}{8}''$ deep, the piece

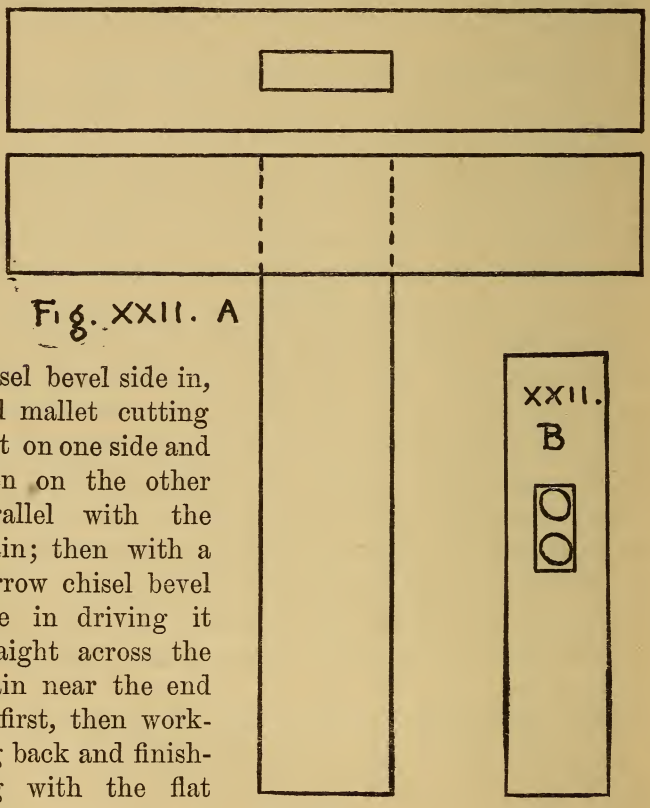


Fig. XXII. A

may be pried out of soft wood, using the chisel bevel side down.

Second Method.—Bore two holes near the end of the mortise half-way through, then turn the stick and finish from the other side (see Fig. 22*b*). Dig out with a chisel as last directed, not finishing to within $\frac{1}{16}''$ of the ends until the last thing, as otherwise the corners will be marred, prying over them.

Third Method.—With a $\frac{1}{4}''$ bit bore holes the whole length of the mortise, and finish as before. Observation will show what part of the marks made with the try-square may be omitted.

The points to be observed are the same as before.

LESSON XXVII.—To make a closed mortise-and-tenon joint at an acute angle.

Working Drawing.—A top view and an end view.

Material.—The same as in the last.

Directions.—Set the T-bevel at an angle of 70°, and the gauge as in the last lesson.

Mark with the gauge the same sides as before, but the long lines which were made before with a try-square should be made now with the T-bevel. The short lines for the waste on each side of the tenon and the ends of the mortise are to be marked with a try-square. If the mortise is dug out by boring holes, great care must be exercised not to let the bit run into the wood outside the ends of the mortise.

Tests.—The same as for any mortise-and-tenon joint.

LESSON XXVIII.—To make a keyed mortise-and-tenon joint.

Working Drawing.—A top view, with dotted lines to show the key. (Fig. 23.)

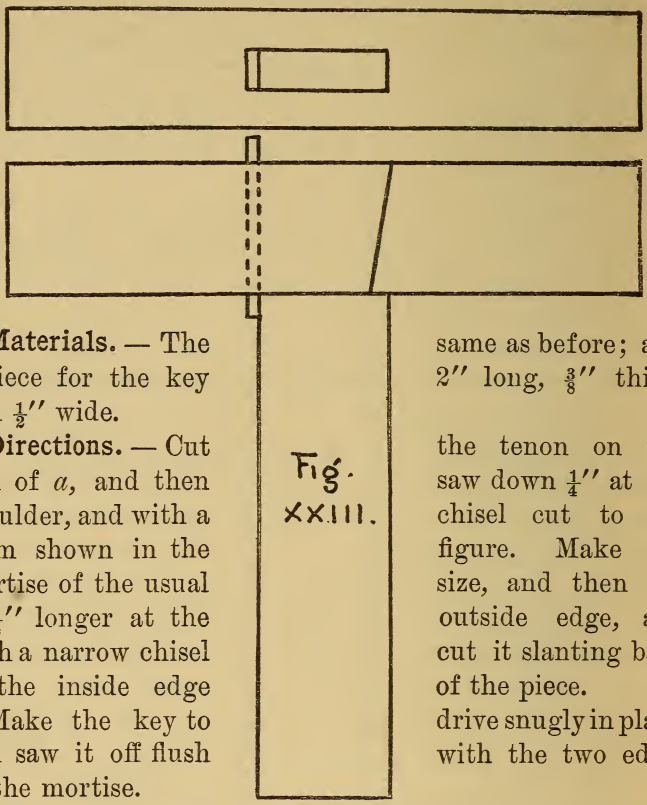


Fig. XXIII.

Materials. — The same as before; also a piece for the key 2″ long, $\frac{3}{8}$″ thick, and $\frac{1}{2}$″ wide.

Directions. — Cut the tenon on the end of *a*, and then saw down $\frac{1}{4}$″ at the shoulder, and with a chisel cut to the form shown in the figure. Make the mortise of the usual size, and then cut it $\frac{1}{4}$″ longer at the outside edge, and with a narrow chisel cut it slanting back to the inside edge of the piece.

Make the key to drive snugly in place, and saw it off flush with the two edges of the mortise.

Tests.—The same as before. This kind of joint is much used to resist tension.

Lesson XXIX.—To make a double closed mortise-and-tenon joint.

Working Drawing.—An end view.

Material.—The same as for Lesson XXV.

Directions.—Lay out the work the same as in Lesson XXV, except that the mortises are to be made near the middle of the piece. The outside of the tenons are to be made as any tenons are; the insides are to be made like mortises. The mortises are to be dug out by boring holes as usual. Great care must be taken in gauging to work always from the same side of each piece, and in cutting to stop at the middle of the gauge-mark.

Tests.—Do *all* the adjacent sides fit tightly? Other tests as in other joints.

LESSON XXX.—To make a blind mortise-and-tenon joint. (See Fig. 12.)

Working Drawing.—View of mortise; also of tenon.

Material.—Same as for Lesson XXV.

Directions.—The blind mortise differs from the other by not extending clear through the piece, and of course requires a shorter tenon to fit.

The process of construction is the same as in the others. The blind mortise-and-tenon should extend as nearly through as possible. It is much used in furniture of all kinds. It is held together by a pin, generally of wood; sometimes by a bolt, as shown in Fig. 12. To bore the hole for a pin in a mortise-and-tenon joint bore the hole through the mortise first. The hole is not bored clear through, but when the point of the bit shows turn the piece over, and finish from that side. Thus a clean cut is made on both sides. Then insert the tenon, and pushing the bit in, mark the centre of the hole. Remove the tenon, and bore the hole about $\frac{1}{16}''$ nearer the shoulder. This results in bringing the pieces nearer together, and making

a better joint when the pin is driven in. Make the pin as directed in Lesson III, and taper the end so it will not strike the second part of the mortise as it is driven in. Drive it in and saw off the projecting ends not quite close,

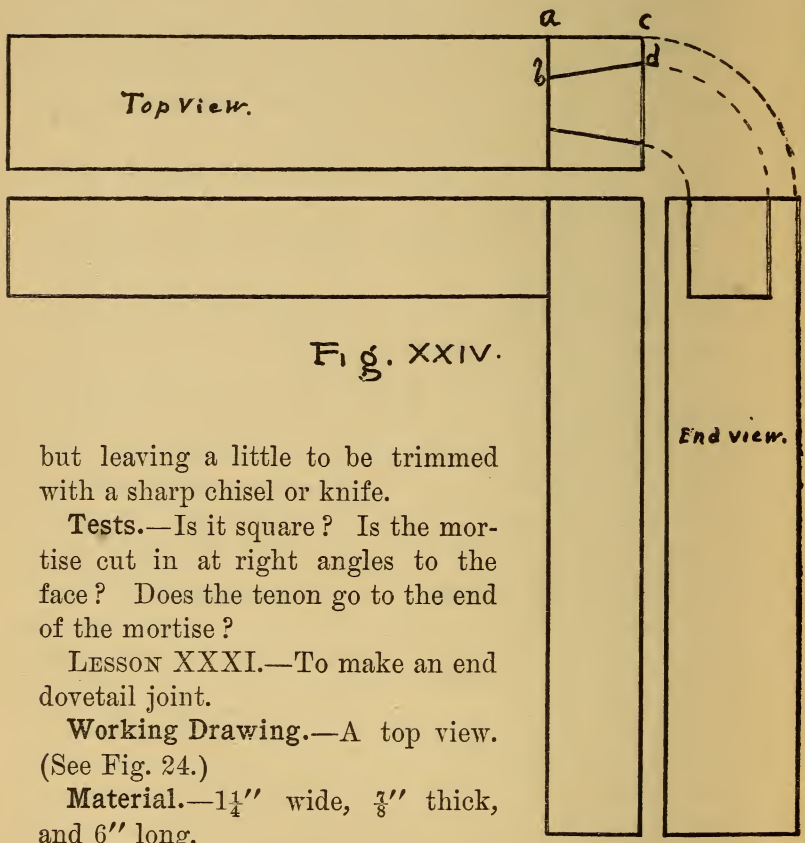


Fig. XXIV.

but leaving a little to be trimmed with a sharp chisel or knife.

Tests.—Is it square? Is the mortise cut in at right angles to the face? Does the tenon go to the end of the mortise?

LESSON XXXI.—To make an end dovetail joint.

Working Drawing.—A top view. (See Fig. 24.)

Material.—$1\frac{1}{4}''$ wide, $\frac{7}{8}''$ thick, and 6″ long.

Directions.—Square one end of each piece, and mark off with try-square $\frac{7}{8}''$ from each end. Lines on the ends

and sides may be drawn with a gauge as usual. The line *bd* and corresponding line must be drawn with try-square after determining the point *b* and corresponding points; *cd* is $\frac{1}{4}''$ and *ab* $\frac{3}{8}''$ long. The waste may be cut away by sawing, but the oblique cut on the tenon will probably be most easily made with a chisel, cutting from the end towards the shoulder with the flat side of the chisel down, the piece being held in a vise. Great care is necessary in cutting the blind end of the mortise not to dig into the sides and so weaken the piece. As will be seen, the property of this joint is that it admits of being separated only in one direction.

Tests.—Is it square? Are the sides flush? Does the tongue fill at all points? Is the end of the tongue just even with the edges of the mortise?

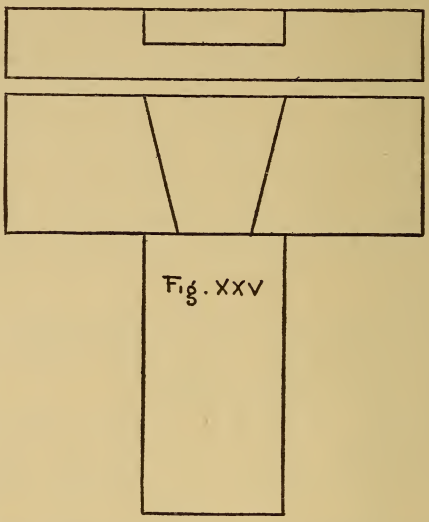
LESSON XXXII.—To make a dovetail middle lap-joint.

Working Drawing.—Side and end view. (See Fig. 25.)

Material.—Two pieces 6″ long, 2″ wide, 1″ or $\frac{7}{8}''$ thick.

Directions.—Gauge at half the thickness at the end of one piece for the tongue on two sides for two inches and across the end. Gauge along through 2″ of the middle of the narrow edges of the piece in which the mortise is to be cut. Lay out the tongue first as a part of a simple lap-joint, and cut it out; then lay off $\frac{1}{2}''$ from the edges at the shoulder, and with a chisel cut the oblique lines, being careful not to take any off the outside corners. Lay out the rabbet as usual, and then take two points $\frac{1}{2}''$ in from the inner ends of the lines on top, lay off the oblique lines as shown, and from the ends of these two lines perpendicular with the top surface. Saw carefully on the oblique lines and work out with a chisel.

Sometimes the tongue is made first and then laid on the other piece, which is marked from the already constructed tongue.



Tests.—The same as for the middle lap-joint. (See p. 33.)

LESSON XXXIII.—To make an end dovetail with two tongues.

Working Drawing.—An end and a front view.

Material.—Same as in Lesson XXXI, only twice as wide.

Directions.—If two pupils have made the piece described in the last lesson, and they are made of the same size, they may be laid side by side and nailed together. We shall then have an end open dovetail with two tongues, and the data for marking may be obtained from this

model. The work now practically consists in cutting mortises on both pieces, the tongues of one piece enclosing a mortise between them. Great care must be exercised to square the ends and mark very accurately, or some of the joints will not be close, and it is about impossible to trim a dovetail joint so as to make it good.

LESSON XXXIV.—To make a half-blind dovetail with two tongues.

Working Drawing.—A top view. (See Fig. 26.)

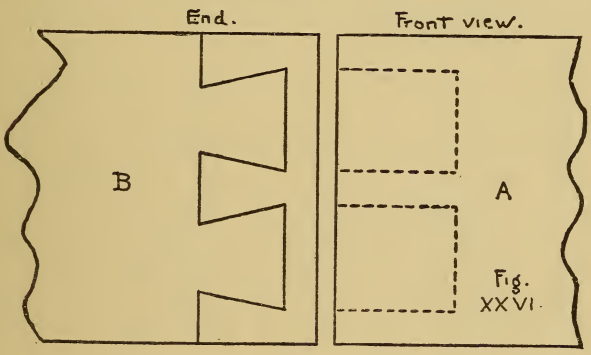


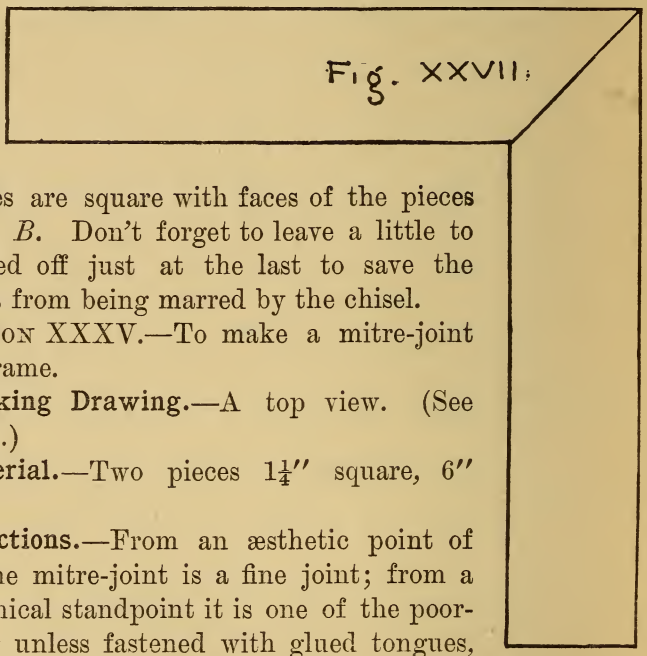
Fig. XXVI.

Material.—Two pieces $2\frac{1}{4}''$ wide, $\frac{7}{8}''$ thick, and 6″ long.

Directions.—If a thin board is laid against one side of the joint last made, its end coming out flush with the other side, it will be seen that the joint is half covered up, and the construction of the joint for this lesson will be understood.

With a gauge mark on the end of the piece *A* $\frac{1}{4}''$ from the edge, and on this line take points $\frac{1}{4}''$, 1″, $1\frac{1}{4}''$, and 2″ from the edge. On the other edge of *A* lay off points $\frac{3}{8}''$, $\frac{7}{8}''$, $1\frac{3}{8}''$, and $1\frac{7}{8}''$ from the same edge. Connect these points on opposite sides as seen in Fig. 26. With a gauge

or try-square lay off a line on each broad side of the piece B $\frac{5}{8}''$ from the end. On the edge and on this line lay off the points the same as on the piece A, drawing the lines for the tongues. The tongues in B are cut the same as before. The mortises in A are cut by the second method for mortise-and-tenon. It is customary to saw down until the saw strikes the upper inside corner and the lower outside corner of the mortise. The saw will be more easily guided if it is *pushed* towards instead of from the end of the piece. Great care must be taken that the blind end of the



mortises are square with faces of the pieces A and B. Don't forget to leave a little to be pared off just at the last to save the corners from being marred by the chisel.

LESSON XXXV.—To make a mitre-joint for a frame.

Working Drawing.—A top view. (See Fig. 27.)

Material.—Two pieces $1\frac{1}{4}''$ square, $6''$ long.

Directions.—From an æsthetic point of view the mitre-joint is a fine joint; from a mechanical standpoint it is one of the poorest, for unless fastened with glued tongues, when it really becomes a mortise-and-tenon joint, it is very weak, and every change of size by moisture and dryness

makes it worse. The pieces must be exactly of the same thickness, and one end of each perfectly square.

On opposite sides of each piece lay off a square *abcd* (see Fig. 28) at the end, and draw the diagonal *ad*, also

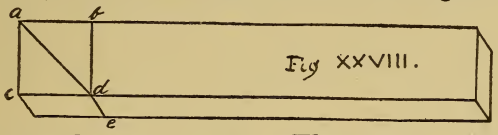


Fig XXVIII.

the line *de*, with a try-square. Then cut carefully on the line *ad* down along the line *de*. If well done, the two pieces should go together like the corner of a picture-frame. If the joint is not perfect the face may be trimmed with a chisel or block-plane. The part *acd* down to the point *e* may be removed by driving a chisel down in the direction *de* or in the direction *da*, in the first case the piece being laid on a bench, and in the second being held in a vise.

Next try to make a mitre-joint with pieces 4″ wide and $\frac{1}{8}$″ thick, the pieces forming the sides of a box. Mark out as before, being especially careful with the square mark.

Place each piece in a vise, and pare off most of the waste with a chisel or shave, finishing with a block-plane. This joint may also be sawed out on a wide or narrow piece if a little of the end projects to keep the saw in place (see Fig. 29), so that as the saw cuts them off they are left of

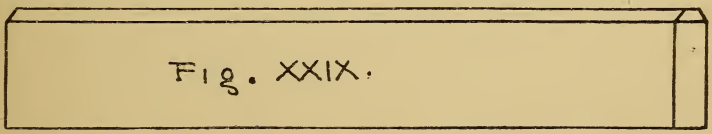


Fig. XXIX.

just the right length. When moulding is cut up with a mitre-box, as in making picture-frames, the saw must be

changed in the slots of the box so that a triangular piece is wasted between each two pieces of frame.

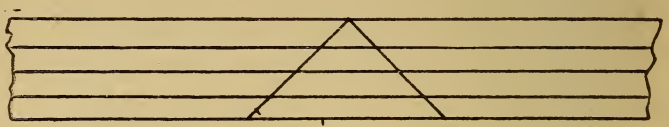


Fig. XXX.

This piece of waste (Fig. 30) has its long side from the *inside* of the moulding.

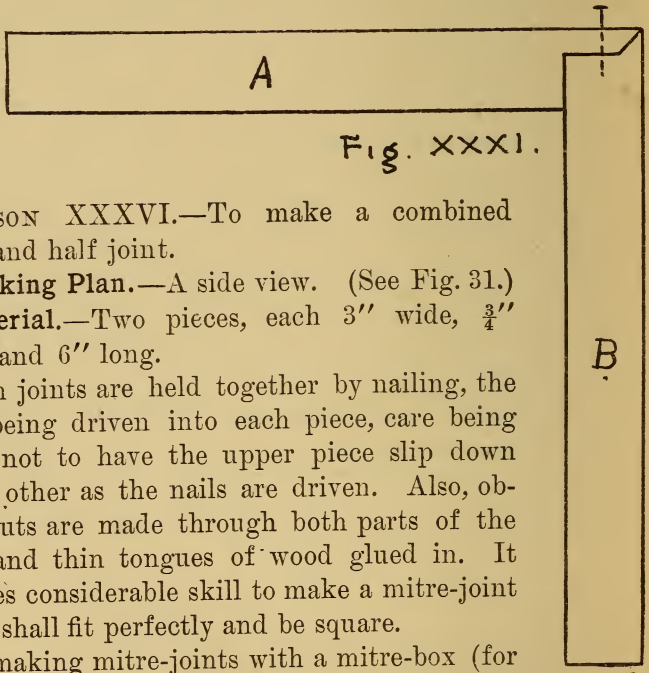


Fig. XXXI.

LESSON XXXVI.—To make a combined mitre and half joint.

Working Plan.—A side view. (See Fig. 31.)

Material.—Two pieces, each 3″ wide, ¾″ thick, and 6″ long.

Such joints are held together by nailing, the nails being driven into each piece, care being taken not to have the upper piece slip down on the other as the nails are driven. Also, oblique cuts are made through both parts of the joint, and thin tongues of wood glued in. It requires considerable skill to make a mitre-joint which shall fit perfectly and be square.

In making mitre-joints with a mitre-box (for directions for making mitre-box see Lesson XL), the box is

nailed down to the bench or screwed into a vise, and the pieces being marked off the right length with a try-square, they are held. Cut the end of each piece perfectly square in both directions. With a gauge mark a line $\frac{1}{4}''$ from what is to be the outer surface on the end of each piece. These lines will be three inches long. On the piece *A* gauge $\frac{1}{4}''$ from the outer surface, on the narrow surface lines $\frac{3}{4}''$ long. On the piece *B* gauge similar lines $\frac{1}{4}''$ long. From the inside surface of each piece mark with a try-square down to these gauge-marks. On the piece *A* $\frac{3}{4}''$ from the end and on the piece *B* $\frac{1}{4}''$ from the end cut with saw and chisel as in making a half-joint. Then mark out the mitre, the inside edge of which is $\frac{1}{4}''$ from the outer surfaces. Cut the mitre with a very sharp chisel, being careful not to cut too deep at the outside corners. The joint may be fastened with glue * or with brads driven through the piece *A* into the end of *B*. This joint is well adapted for the corner of a box or chest, as it combines the ele-

*Glue is prepared by soaking overnight in cold water. The surplus water is then poured off, and the glue melted by heating in a dish of water. It must be ropy and hot when applied, and the pieces are clamped together when dry. When glue is applied to the end grain of wood, a thin coat of sizing, which is thin glue, is applied, and allowed to dry first before the final application is made. To make a cheap glue-pot take two old tin cans—a pint can and a quart can. Place the top of each over an oil-stove until the solder melts and the ragged rim can be knocked off. The smaller can may then have two slits $\frac{1}{2}''$ apart, cut down $\frac{1}{2}''$ on one side. The part between the cuts may then be bent over to form a lug or ear to hook over the top of the quart can. Heat the glue in the small can by the water kept hot in the large can. Buy a small bristle-brush to use in the glue-pot. Nothing else spreads the glue properly.

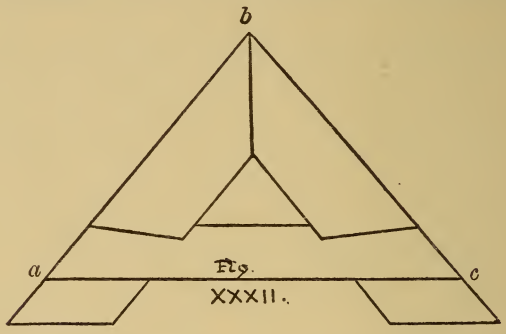
gance of the mitre-joint with the strength of the half-joint.

LESSON XXXVII.—To make a model for a truss.

Working Drawing.—A side view. (See Fig. 32.)

Material. Pieces 2″ wide and $\frac{7}{8}$″ thick.

The joint *b* (Fig. 32) may be of any angle desired, and may be mortised as well as mitred. The joints *a* and *c*



are half-dovetail, halved into the rafters. Make the mitre-joint first and fasten it, then lay the pieces on to the cross-piece to get the angle for the half-joints. After the cross-piece is halved and the dovetail cut it may be laid on the pieces and the size of the rabbets got directly from the tongues. Use the gauge to get the thickness of the pieces, and be sure that the narrow sides of the tongues are cut square with the broad faces; otherwise they will not fit.

Varieties of this may be made by mortising *a* and *c*, making a keyed mortise-and-tenon joint.

It will be seen that such a combination of three pieces makes a firm frame, resisting any attempt to change its shape in any particular. Any number of varieties of truss may be made, and incidentally a little instruction may be

given on the theory of the truss, and its use in bridges and roofs.

LESSON XXXVIII.—To make a dowel-joint.

Working Material.—1 piece $1\frac{1}{2}''$ square and 6″ long, 1 piece 3″ wide, 1″ thick, and 6″ long.

Drawing.—Side and end view. (See Fig. 33.)

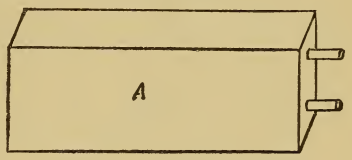


Fig. XXXIII.

Directions.—A dowel is a small pin of wood or metal, generally of the former, used instead of a tenon to unite two pieces of wood. It is used in such places as to fasten the frame of a table to the leg, to hold the edges of two boards together, etc. The narrow strips of which school desks are made are now held in the same plane by small wire dowels in all the best desks.

With a gauge mark the piece *A* (Fig. 33) through the middle of the end the long way. Mark the piece *B* through the middle on one side. Lay *B* on the bench with the marked side up, and place on the mark two small shot $\frac{3}{4}''$ and 2″ respectively from the end. Place the piece *A* with the end on the side of *B*, with the narrow edge of *A* even with the end of *A* and the gauge-marks coinciding. Strike the other end of *A* a smart blow with a hammer, and the shot will mark the side of *B* and the end of *A*. Where these marks are, bore $\frac{3}{8}''$ holes $1\frac{1}{4}''$ deep.

Prepare a dowel-plate by taking a thick butt or hinge, and with a reamer enlarge the screw-holes till one is a trifle more than $\frac{3}{8}''$, and the next $\frac{3}{8}''$, and the other $\frac{1}{2}''$ in diameter. With a file smooth off the burr made by the reamer. Split an oak pin $\frac{1}{2}''$ square and whittle off the

corners and drive it through the holes, beginning with the largest. Have the dowel-plate over a hole in the bench, or across the iron vise jaws, or over a hole in the anvil if you have one. Drive in the pin with the small end of the hole in the dowel-plate (the hinge) uppermost.

Plane off two shavings from one side of the dowel for the escape of air and glue, when it is driven in, and cut into $2\frac{1}{8}''$ lengths. Apply hot glue and drive into the

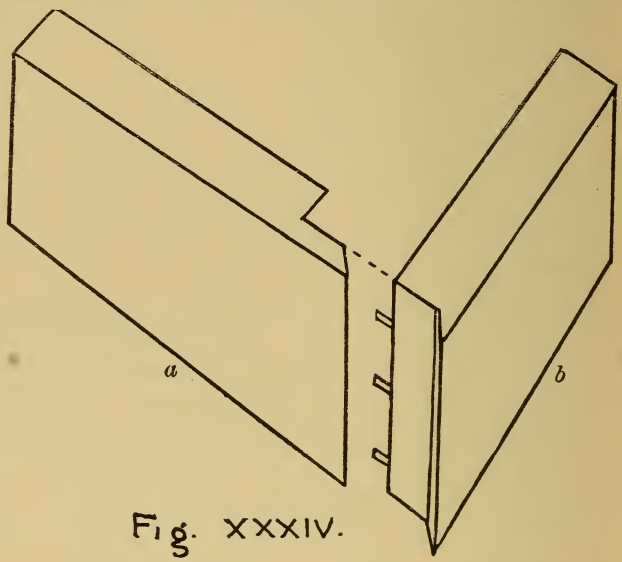


Fig. XXXIV.

piece *b*, and then drive *a* on to the dowels, putting a piece of waste wood under the hammer to prevent marring.

It is well to run a rose-bit into the holes of one piece to make a countersink for the surplus glue to collect. Otherwise it will ooze out, and prevent the two pieces from coming close together and making a good joint. Al-

most any of the joints may be fastened together with dowels.

LESSON XXXIX.—To make a blind dowel-joint with a mitre.

Working Drawing.—A view of edge of each piece (Fig. 34).

Materials.—Two pieces 3″ long, 2″ wide, 1″ thick.

Directions.—In making this joint the ends of the pieces are first squared, then the half-joint is made $\frac{3}{4}$″ deep, and then the mitre cut, after which the marks are made for the dowel. The piece *a* should be screwed into a vise with the inside in front, with another piece behind it coming up a little above. The shot should be laid on, and the piece *b* resting on them must be pushed back until the sharp edge of the mitre hits the board behind *a*; then strike *b* to make the shot mark it. Care must be taken not to bore the holes in *b* too deep and so have the spur of the bit come through.

Chapter IV.

LESSON XL TO L INCLUSIVE.

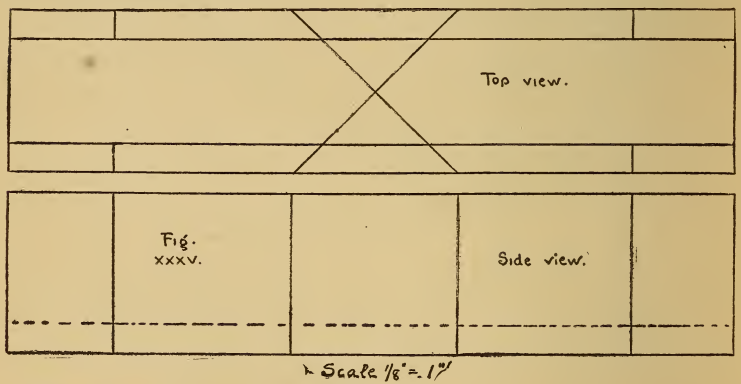
CONSTRUCTION OF MITRE-BOX.

Picture-frame, Screens, Frame and Panel, Shoe-blacking Stool, Step-ladder, a Drawer, a Bookcase, Screen-door, Box and Cover.

LESSON XL.—To make a mitre-box.

Working Drawing.—A side view and top view (Fig. 35).

Material.—Three pieces 28″ long, 4″ wide, $1\frac{1}{8}$″ thick, and 20 tenpenny nails.



Directions.—Get out each piece with square ends and edges, and nail firmly together to form a square trough or gutter. Put in the nails, two in each division of the side.

Four inches from each end and exactly two from the middle draw lines across the tops and down the sides. Fasten the box in the vise, or nail to the bench, and with a sharp back-saw cut down on the lines through both sides as far as the bottom.

Saw the lines at the end of the box straight across, but those at the middle, on the diagonals of the square formed by the lines, across the top and the edges of the side.

To use the mitre-box a piece of moulding is laid against the further side and held firmly with the left hand while it is sawed by a saw running down in the slots. Pieces may be cut off square or at an angle of 45°.

Test.—Cut off two pieces of moulding and try them to see if they meet at an exact right angle. Saw off a piece at the slots at either end and apply a try-square to them. Are the sides at exactly right angles to the bottom? (It is well to put the pieces of the box together with glue as well as nails.)

LESSON XLI.—To make a picture-frame 15″ × 20″.

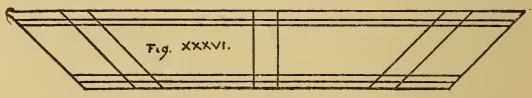
Material.—Moulding made or bought one inch more than the length of the four sides of the completed frame inside plus eight times the width of the frame.

Directions.—The simplest way is to use moulding already made, cutting the moulding in a mitre-box and joining the corners. Most pupils, however, would prefer to make the whole thing themselves.

It is now customary to make frames out of everything, from the lichen-covered boards of an old fence to the solid gilt, so that a mistake can hardly be made. For this exercise the material may be 3″ wide, with flat face chamfered on each edge. If the pupil is strong he may get a piece

of oak flooring $\frac{7}{8}''$ thick; otherwise it had better be made of softer wood. Six feet in length will be required. It must be gotten out of exactly the same width, and edges should be square with the front face.

For chamfering it should be marked *very lightly* $\frac{1}{4}''$ away from the corners, and the chamfering is to be done with a plane set fine and sharp. The under side is to be rabbeted $\frac{1}{2}''$ wide and $\frac{3}{8}''$ deep, leaving $\frac{1}{4}''$ of thickness between the bottom of the rabbet and the chamfer. Select such surfaces to rabbet and chamfer, and do it in such a direction, that it will make a smooth job. After the moulding is done it is to be sawed in the mitre-box. The pupil should practise sawing on something else until he is sure of making a good job. If the frame is of oak it will be difficult to nail the corners and have them right. The corners should be fastened in a vise and drilled with a twist-drill. A good way to fasten the frame together is to put an iron on the back side of the joint. These irons may be $\frac{3}{32}''$ band-iron, $\frac{3}{4}''$ wide, 3″ long, each piece drilled with two holes near each end. These holes should be countersunk for screws. The faces of the moulding may be decorated by cutting narrow, shallow rabbets with a fine saw and $\frac{1}{8}''$ chisel, being careful to make the bottom smooth. These rabbets may be of any design preferred; one is given in Fig. 36.



If the frame is of oak or ash it may be finished by applying a very thin coat of asphaltum stain and then rubbing

it off immediately with burlap, or sand-papering it all off after it is dry, except what has soaked into the grain. It may then be varnished. This makes antique oak or ash. Part of it may be scorched over an oil-stove or lamp. The glass and backing may be purchased. After the picture is in all right paste a sheet of heavy manila paper over the back, applying the paste only at the edges, to keep out dust.

Tests.—Are the corners square? Do the corners fit? Does the frame lie flat? Is the surface smooth? Are the opposite sides of equal length?

LESSON XLII.—To make frames for a screen.

Working Drawing.—A top view. (See Fig. 37.)

Material.—The material will of course depend on the size of the screen and the number of panels. For a screen

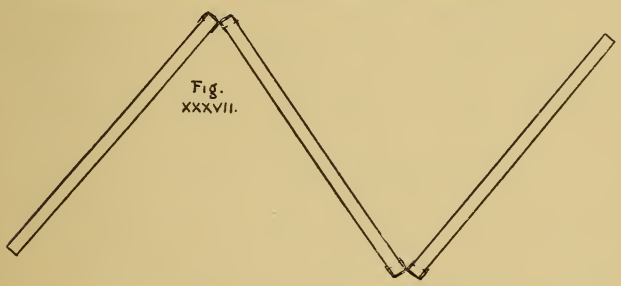


Fig. XXXVII.

of three panels, five feet high and each panel 18″ wide is a good size. For such a screen 39 feet of material will be needed, $1\frac{1}{2}'' \times \frac{7}{8}''$, viz., six pieces each 5′ long and six 18″ long.

Directions.—The corners may be joined by an end lap or a mortise-and-tenon, according to the amount of work desirable to put on it. The pieces for each frame must

be got out so that the frame will be of exactly the same size, corners and ends square, etc. Great care must be exercised to joint the pieces together so that the frames will lie flat on a plane surface. The three panels are to be hinged together in such a way that they will swing either way. Hinges for this purpose are made with two strips of black tape tacked tightly on to opposite sides of adjacent parts, as shown in Fig. 37. Two strips of tape must be put on for each hinge and drawn tight, so that there will be no large crack at the joint.

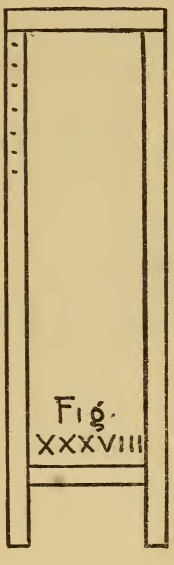


Fig. XXXVIII

If the frames are made of pine they may be stained with some of the liquid stains which may now be bought in small cans. The cover for the panels may be of anything from five-cent print to canvas, covered with oil painting. Some designs of calico make a very neat covering. Brass-headed tacks add much to the neat effect. It is well to put the lower cross-bars several inches above the lower ends of the uprights. (See Fig. 38.)

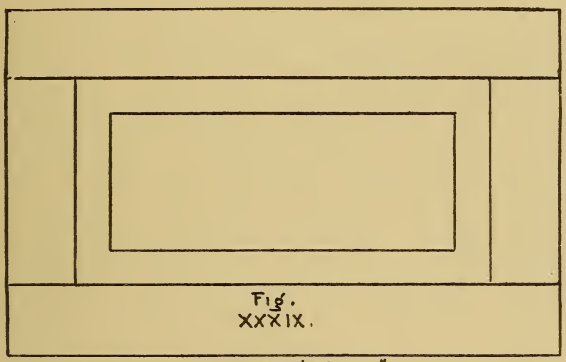
Lesson XLIII.—To make a frame and panel.

Working Drawing.—Front view, view of top rail showing relish.

Material.—For the frame, stuff 2″ wide and $\frac{7}{8}$″ thick; for the panel, $\frac{1}{2}$″ stuff. A good size for an exercise in panelling is 10″ × 16.″

Directions.—Prepare two pieces for the frame 27″ long and the right width and thickness. It is better to groove them for the panel before cutting into shorter pieces.

With the groover of a pair of matching-planes, or with a "plow," make a groove $\frac{1}{4}''$ wide and $\frac{3}{8}''$ deep. The edges of the piece must be perfectly square, and the piece is held in a vise. It is well to try the plane on a piece of waste, to see that it works all right. Before grooving, decide which is to be the outside of the frame, and choose that side with reference to the grain, so that that edge of the groove will



be smooth. Take a piece of not very straight-grained wood and groove it for a trial, and it will be seen that one edge of the groove is smooth and the other edge is splintery. Be sure and hold the plane up close against the work so that the groove will be at all places equally distant from the edge; also be careful that the plane is vertical, otherwise there will be trouble in putting in the panel. After the pieces are grooved they may be cut apart and mortised-and-tenoned. The long pieces are called *stiles*, and the short ones *rails*. The mortises are cut in the stiles, and the tenons on the rails. The mortises should coincide with

the grooves, and a short portion of the tenon called a *relish* must be left as long as the depth of the groove and extending to the outer edge of the rail. (See Fig. 40.) This

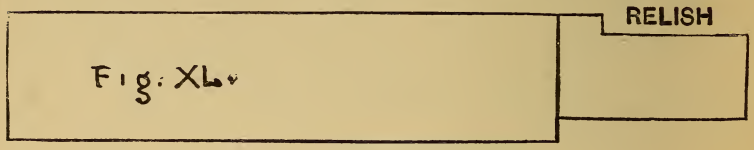


Fig. XL.

piece is necessary to fill up the part of the groove between the mortise and the end of the stile.

Put the frame together and make the panel $\frac{5}{8}''$ longer and wider than the space inside the frame. That will leave $\frac{1}{8}''$ for it to swell on account of the dampness. The panel should be rabbeted about an inch wide to fit the groove. The rabbet should not be as deep at its inner edge as at the edge of the board, as may be seen by examination of any door. It may be rabbeted on both sides if preferred. It must be thinner at the edge than the width of the groove, or it will split when it is driven in, since it is tapering. (See Fig. 41.)

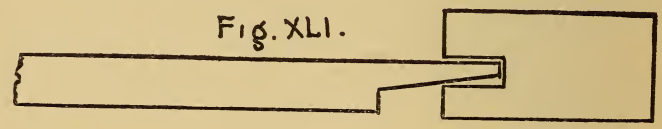


Fig. XLI.

Beginning one inch from the inside corner, the rails and stiles may be chamfered and add somewhat to the appearance. To do this the frame must be taken apart. Mark with a gauge $\frac{1}{8}''$ from the edge on adjacent sides to within $\frac{1}{8}''$ of the end of the chamfer. With a chisel begin back $\frac{1}{8}''$

beyond the lines and cut down to the gauge-marks and follow along, taking off a piece of triangular section from the corner, not all at one cut, but with several. The oblique cut down to the gauge-marks may be straight or curved; if straight it is a bevel, if curved an ogee. Great care must be exercised in this work not to cut too deep, and the grain must be observed and the cut made in such a way that the wood will not splinter. In cutting the rabbet across the end, mark it out with the square and cut down with a knife, and have the plane very sharp, or use a chisel, as in making a half-joint. Nail a cleat across near the end to guide the knife and the plane.

Tests.—Is the frame the same width at each end? Is the frame square? Does the frame lie flat? Are the surfaces of the rails and stiles parallel? Does the panel fit at all parts of the frame? Is the raised part of the panel square? Does the relish fill the groove? Are all the mortise-and-tenon joints perfect?

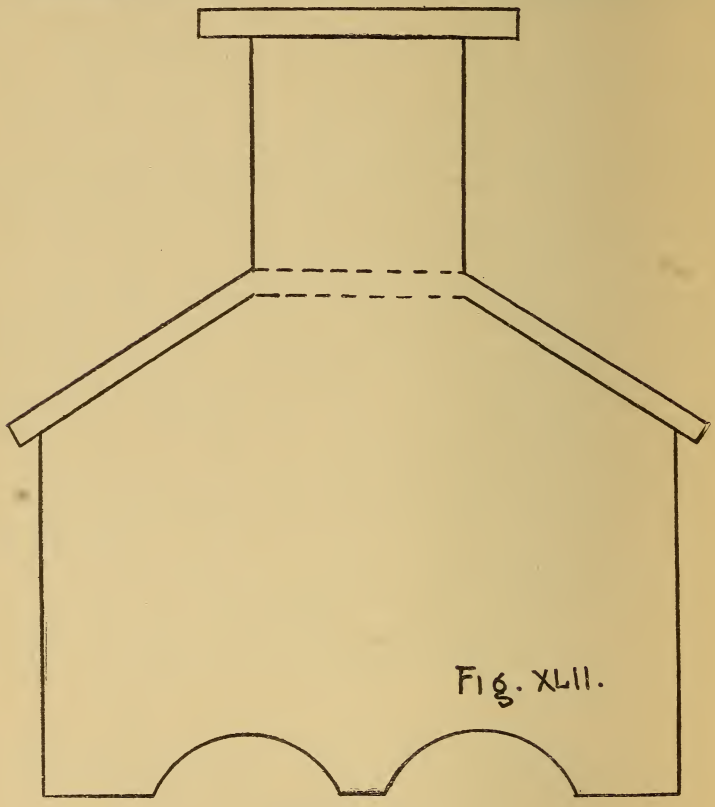
The frame may be fastened together with glue or pins. Do not glue the panel, or it will split when it shrinks. Cheap furniture is made without mortising the stiles, the tenons being only as long as the depth of the groove, and the whole glued together. Such work comes to pieces after a little exposure to changes of temperature, moisture, and dryness.

When a pupil becomes very skilful he may make a model of a door with four panels. Doors are now mostly made by machinery, and the stiles are left a little long to prevent marring the rails as they are handled. This extra length is sawed off after the doors are thoroughly seasoned, when they are fitted. Instead of cutting the inside

of the frame square the edges may be bevelled. In this case it is necessary to mitre the bevelled part.

LESSON XLIV.—To make a shoe-blacking stool.

Working Drawing.—An end view (see Fig. 42). This



Scale $\frac{1}{4}'' = 1''$.

represents one end view, showing the end of the foot-rest, the ends of the covers (hinged at the top), and the form of

the end pieces, which may be varied to suit the fancy of the maker.

Material.—Two pieces 15″ long and 12″ wide for the ends; one piece 11½″ long, 11″ wide, for bottom; two pieces 11½″ long, 8″ wide, for side pieces; two pieces 13″ long, 5½″ wide, for covers; one piece 11″ long, 4″ wide, for piece to hinge the covers to ; one piece 6″ wide, 13″ long, for foot-rest. All of ½″ stuff.

Directions.—Get out all the pieces with the edges square with the sides, except the covers, which may have the front edges rounded and the other bevelled to fit the top. One or both of these covers may be hinged. It will be observed by the measurements that the box is to be 12″ long, that the bottom and sides are to be inserted into rabbets ¼″ deep in the ends, and that the covers and foot-rest extend over ½″. The curves at the bottom may be cut with a keyhole saw and made smooth with a rasp. Put in the bottom and top board and nail firmly together with 1½″ finish nails. It is well to finish the end pieces fastened together, in order that they may be alike. Care must be exercised to have a good true piece that is not warped for the bottom, or the stool will not set down on the floor firmly. Unless the lumber is first-class it might be better not to rabbet for the bottom, but to fasten the bottom firmly to one end and then put one nail through the other end into the bottom. Then set the stool on to a plane board or the floor, and mark on the inside of the end which has only one nail in it. Then nail the bottom in place, putting in first one nail part way and trying to see if it is right and if it is nailing firmly. In this way it is easy to put the stool together true. If the side pieces are

warped, put them on in such a way that the unevenness of one will counteract that of the other. The stool after completion should be sand-papered with fine paper, when it may be stained and varnished. The main thing to be observed is to have the stool stand firmly on all four legs, and to have the covers shut evenly. Of course the side pieces must be gotten out square, or the thing will not be upright.

LESSON XLV.—To make a step-ladder. Height of ladder about four feet, number of steps, five.

Working Plan.—End view. (See Fig. 43.)

Material.—Two pieces of $\frac{7}{8}''$ stuff, 6″ wide, $4\frac{2}{12}$ feet long; 7 feet of $\frac{7}{8}''$ stuff, 7 inches wide, for steps; two pieces for supports, $\frac{7}{8}'' \times 2''$, and 4 feet long; two braces, $1'' \times \frac{1}{2}''$, and 4 feet long; two 2″ screws, nails, screws, etc; two pieces of wire 4 feet long to brace the steps; two wires 2 feet long for hooks; four screw eyes. The two wires for hooks may be the size of a water-pail bail, the two for braces about one half as large.

Directions.—Get out the two side pieces and lean one of them up against a wall, so that, when the upper edge touches the wall, the bottom will be 30″ from the wall. One corner will then be up above the floor, as shown in Fig. 43.

Set a pair of compasses with the points as far apart as this corner is above the floor. Draw them along with one point on the floor and the other on the side of the board. (This process is called *scribing*.) The point will make the line *ab*, along which the line is to be sawed. Reverse the piece so cut off and use it as a pattern to cut off the top of the board. Cut off the other side board of the same shape,

using the first as a pattern. Set the bevel (Fig. 57) at an angle like that at the corner *a* or *b*. Subtract $4\frac{3}{8}$″ from

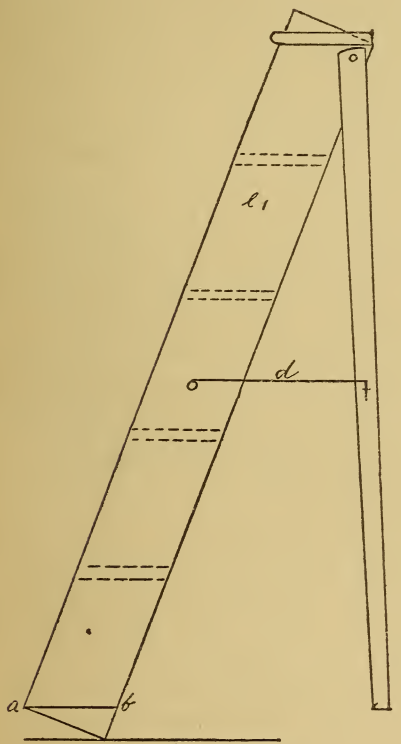


Fig. XLIII.

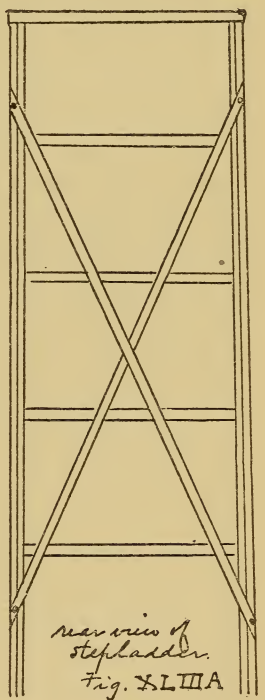


Fig. XLIIIA

the length of the line *ac*, and divide the remainder by 5; this will give the distance between the steps. Lay off the

lines for the under side of the lower step, and $\frac{7}{8}$″ above another line parallel for the upper side. Do the same for the succeeding steps. Rabbet for the insertion of the steps $\frac{3}{8}$″ deep. Cut the lower and upper step each 18″ long; lightly tack in the lower step and put the upper step on top of the side boards, allowing it to extend over 1″ at each end. This makes the steps taper properly, and the frame should now be adjusted to have the angle the same at each end of the lower step. The length and angle can now be obtained for sawing off each of the other steps. Lay the edge of the board for the step against the side pieces and mark with a pencil; then mark with a try-square on both sides of the board. Hold the saw at such an angle that the step will fit at the upper and under side. Try the steps first to see if all goes together well, then nail lightly at first, and after adjusting nail firmly. The pieces for support may now be gotten out and tapered until they are only an inch wide at the lower end. One may be used as a straight-edge to mark the other with. The top of each is to be rounded and bored with a hole countersunk to receive a screw, about which it turns. This screw is firmly driven into the side pieces in such a way as to allow the supports to turn freely without hitting the top step. Shut these supports until their back edges and the corresponding edges of the ladder coincide, and then screw on the braces diagonally. Two long hooks of wire, *d*, are to be pivoted on to the side pieces to hook into staples or screw-eyes on the supports, to keep them from shutting when the ladder is in use. Extra staples may be put into the side pieces to hold these hooks when the ladder is not in use and the supports are closed. If the ladder does not seem perfectly firm, two

wires may be stretched diagonally across the back side to stiffen it. The front of each step may be half rounded if desired. Have the supports spread a little beyond a point vertically under the screw about which they turn, in order that the ladder may not tip up when in use. Do not have the top step project over the back side. The top step may be an inch wider than the other if desired.

LESSON XLVI.—To make a plant-stand.

Working Plan.—A front, side, and end view—pupil's design.

Material.—The size and height of the stand will be determined by the place in which it is to stand and the number of plants it is to hold. Supposing it is to hold a

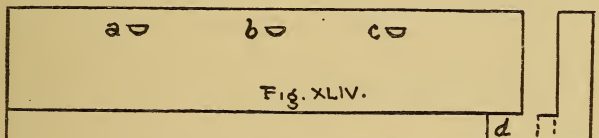


Fig. XLIV.

Scale $\frac{1}{8}'' = 1''$

box 30″ long and 8″ wide, the top may be of that size and the frame of the table should be 2″ narrower and 6″ shorter. Make the legs of pine, $1\frac{1}{4}''$ square, chamfered to within 6″ of the top. The frame should be of $4'' \times \frac{7}{8}''$ stuff, and may be mortised or dowelled into the legs. The pieces should set in $\frac{1}{4}''$. The legs should spread so that the width between them at the bottom is 8″. To get the bevel for this lay off on the floor two lines 6″ apart at right angles to the wall; lay the legs on these lines and then spread them 2″ at the bottom. Then set the bevel between the wall and a leg; this is to be used for marking

the end pieces. The side pieces being marked in the same way will give the legs a spread in the other direction. The frame is to be fastened to the top by four screws put up through the inside of the side pieces, as shown in Fig. 44, at *a*, *b*, *c*.

Tests.—Does it stand squarely on all four legs? Are the lower ends of opposite legs the same distance apart? Do the legs spread equally?

LESSON XLVII.—To make a drawer 15″ long, 8″ wide, and 3″ deep.

Working Plan.—End view, top view.

Material.—One piece 8″ long, 3″ wide, 1″ thick, for the front; one piece $7\frac{3}{4}$″ long, $2\frac{3}{8}$″ wide, $\frac{1}{2}$″ thick, for the back; two pieces 15″ long, 3″ wide, and $\frac{1}{2}$″ thick, for the sides; one piece 14″ wide, $7\frac{1}{2}$″ long, $\frac{1}{2}$″ thick, for the bottom. The front may be of walnut or other hard wood; the rest of pine or white-wood, which is much used for this purpose.

Directions.—Plane the front smooth and gauge on the end $\frac{1}{4}$″ from the front face. Gauge on the back side $\frac{1}{2}$″ from the end. Plane the sides and groove them on the inside at the bottom with a $\frac{1}{4}$″ groove, $\frac{1}{4}$″ deep, the inside edge of which is $\frac{5}{8}$″ from the lower edge of the pieces. Cut rabbets $\frac{1}{2}$″ wide across the inner ends, whose outer edge is $\frac{3}{4}$″ from the back end of the side pieces. Put the side and front pieces together with a half-blind dovetail (Lesson XXXIV). Fasten the back piece into the rabbets, having the upper edges even and the lower edge just to the top of the groove for the bottom. Rabbet the under side of the ends and front edge of the bottom, and slide it into the groove and fasten it near the front end with brads. If

it is difficult to get a board wide enough, glue two pieces together. If it is only fastened at the front, it will slide in the grooves as it shrinks and swells, while, if it is fastened at both ends, it will split as it shrinks. The reason for putting in the bottom this way of the grain is, that, if the grain ran lengthwise, when the bottom swelled it would crowd out the sides and so make the drawer rub hard. Moisture and dryness affect lumber much more in width than in length.

Tests.—Are the upper surfaces of the sides parallel? If not, the drawer will not slide easily. Are the sides parallel? If not, they will fit too loosely in one part, and bind in another. Is the angle between the front and the sides a right angle both ways? If not, the front will not be even with the front of the piece of furniture into which the drawer slides.

To make a slide for the drawer, for instance, under the work-bench, take two pieces of $\frac{7}{8}''$ stuff an inch longer than the drawer and $1''$ wider than the side pieces. From one corner of each piece cut a square $\frac{7}{8}''$ on each side *a*, (Fig. 44). This is to receive the ends of a $\frac{7}{8}''$ square pieces $9\frac{7}{8}''$ long, which goes under the front of the drawer to support it. The dotted line (Fig. 44) represents a cleat $\frac{7}{8}''$ square, which is fastened with screws or nails and glue to the inner side of each piece and upon which the drawer slides.

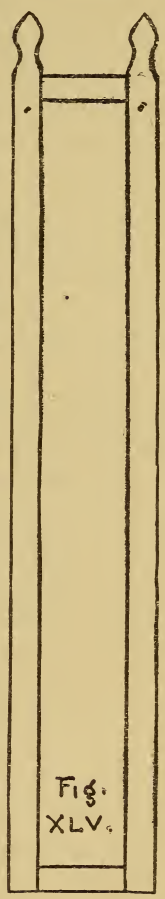
At *a*, *b*, and *c* a notch is made to allow a screw to be put up through each piece into the bottom of the bench. The straight part of this notch is made with a knife, deep in the middle, and the rest with a gouge. (If such a notch is not familiar it may be seen on the under side of any

table.) After the notch is made, bore a hole up through to receive a screw. Decide where the drawer is to be and screw one piece firmly in place. Then put the drawer in place, and the other piece with a thin piece of pasteboard (box cover) between it and the side of the drawer. Now cut off the piece that is to go into the notches just the right length, and fasten it in place with screws. Instead of making notches for the screws in the side pieces it is sometimes best on narrow pieces to bore a $\frac{1}{2}''$ hole to within an inch of the upper edge and finish with a smaller hole for the screw which is then put in, the $\frac{1}{2}''$ hole allowing the screw-driver to follow it up. A better finish is made for the front, also, by not cutting the notches for the front piece underneath, but putting pieces of the same thickness on to the front of the side pieces. In this way no end grain of wood is exposed. The pasteboard at the side being removed, the drawer will be found to have just about enough play to allow it to slide easily. A picture-knob may be screwed on for a drawer pull, or if there is a turning-lathe one may be turned.

LESSON XLVIII.—To make a bookcase. The bookcase described is designed to stand on the back of a study table against the wall, and the length of the shelves will depend, of course, on the length of the table. It can be made with only two shelves if desired, and the height thus reduced 8 inches. The side pieces may be made of black walnut, and the shelves may be stained and have a thin strip of walnut in front, or the whole may be made of different wood and stained or not, according to the taste of the maker. Size of bookcase described, 34″ high, 36″ long, 7″ deep.

Working Drawing.—End view, front view.

Material.—Four pieces for the stiles, 34″ long, 1½″ wide, ⅞″ thick; four pieces for rails, 6″ long, two of them 3″ wide and two 1½″ wide, ⅞″ thick; two pieces for panels, 23½″ long, 5″ wide, and ½″ thick; four shelves, 34″ long, 7″ wide, ⅞″ thick; one piece of moulding to go around front and sides, 52″ long; eight 2″ roundhead, blued screws for the top and bottom shelves; eight large screw-eyes to hold up the two middle shelves; brads to fasten the moulding in place. The space between the bottom and second shelf is to be 10½″, the next space 8½″, and the next 8″, though these can be changed.



The upper shelf is fastened by screws going through the stiles, as shown in Fig. 45, the lower surface of the shelf being on a level with the under side of the upper rail.

The lower shelf may be rabbeted into the stiles and rails, in which case it must be cut 34½″ long. It is fastened by screws passing through the stiles and comes down even with them. The stiles and rails are mortised together as in Lesson XLIII, and *afterwards* are rabbeted to receive the panel. The rabbet is on the inside, and must be of such a depth that the panel is flush with the surface of the stiles on the inside, so that the books will

not rub against any corner either in coming out or going in. The panel may be rabbeted on the outside or not, but the stiles and rails will look better if chamfered, and the stiles should be chamfered on the outside front corner; also the rails on the outside upper corner. The panel may be fastened in with glue and short brads, being careful not to have them come through the stiles, and setting in the heads so that the books will not be scratched by them.

It is a good plan to fasten two wires diagonally across the back, as in the case of the step-ladder, to keep it square. At a distance of $9\frac{1}{2}''$, $10''$, $10\frac{1}{2}$, $18''$, $18\frac{1}{2}''$, $19''$, and $19\frac{1}{2}''$, bore small holes in the inside of the stiles, into which the screw-eyes may be put to hold up the two middle shelves. Put the screws clear in and turn them so that the shelves may rest on the flat surface of the eye. Of course only eight screw-eyes are to be used, and these are to be put in where the shelves are wanted, and changed as desired.

The concave curves for the fancy tops of the stiles may be made by fastening two together side by side in a vise, and boring through with a $1''$ bit. Turn the pieces over so as to make a clean cut on both sides. The other curves may be made with shave or chisel. Make a paper pattern first and use, to have the tops all alike. Put the moulding around the front and sides, mitreing the corners.

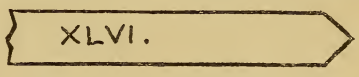
LESSON XLIX.—To make a screen-door.

Working Drawing.—Front view.

Material for this will depend on the size of the door. The material should be $1\frac{1}{8}''$ thick and $4''$ wide for the stiles and top rail and the mullion, and $6''$ wide for the

lower rail. For the upper rail the mortise should be ½″ wide and 3″ long, extending within 1″ of the top of the stile. For the lower rail it may be 4″ long, extending to within an inch of the end of the stile. The mullion may have a short tenon or be put in with dowels. Extreme care is necessary in making such a large frame with mortise-and-tenon joint to have it true, so that it will shut even. It should go just inside the door-casing and have a stop to prevent its shutting in too far. If after the door is made the upper corner shuts in too far, put the stop at the top; if the lower corner shuts in too far, put the stop at the bottom. In this way the door will gradually be brought to place. If it shuts even, put the stop at top or bottom, or, better, all the way up.

The screen wire is nailed on and a ½″ moulding placed over it, mitred at the corners. A piece of moulding should be put across the middle of the mullion, and it is joined on to the other moulding by a process called coping. The moulding is to be cut of such a length that the ends extend just to the middle of the moulding ; then cut it in such a way that there is a right angle at the middle of the end (Fig. 46). With a sharp knife cut out on the under side of these ends until they fit over the moulding. This is better than cutting out a notch in the moulding on the stiles, as it is in that case liable to break. Get hinges with a loose bolt and fit them by marking with gauge and try-square, as explained in Lesson L. Get hinges wide enough to bring the bolt out so far that the door may swing wide open. A spring to close the door may be purchased, and will have with it directions for putting it on.



LESSON L.—To make a box 12″ long, 8″ wide, and 4″ high, with hinged cover.

Material.—One piece 4″ wide, 41″ long, ½″ thick; two pieces 12″ long, 8″ wide, and ½″ thick.

Working Drawing.—A top, side, and end view.

In making a box with a cover like a trunk cover, it is best to make the box and cover all together and saw them apart. The piece for the sides and ends must be nicely planed with a smoothing-plane, but not sand-papered until all work on it with tools is done. The reason for this last is that small grains of sand stick into the wood and thus dull the tools if they are used on it afterwards. Rabbet this piece on one side ½″ wide and ¼″ deep, to set the bottom up in. Mark with gauge to have it accurate. After this cut the sides 12″ long and square them accurately, and cut the ends 8″ long and square them. Make the corner joints a combination half and mitre joint, as described in Lesson XXXVI. Be sure that the ends of the pieces are perfectly square. Sometimes the corresponding pieces, as the two ends, are clamped together and squared in this way, to be sure that they are just alike. Fasten the sides and ends together with glue or brads. If they are fastened with brads the heads should be set in with a nail-set and the holes filled up with putty or a little chip of wood of the same kind glued in. In this case the grain must run the same way as that of the piece.

While the box is drying it should be fastened with clamps or wedged into some place where it will be held perfectly true and square. Measure accurately the size of the place into which the bottom is to fit, and cut the bottom to size. If the frame is square it may be laid on to the piece for the bottom and the bottom marked directly

from this. This marking should be done with a fine pencil or knife. Lay the frame on to the piece for the cover and mark in the same way. Then gauge the edges of the cover in the middle and rabbet one half the thickness, so that it will go down into the sides and end just one half its thickness. Fasten this and the bottom in place with glue, and when the glue is dry, trim the cover just to the sides and ends with a very sharp block-plane. Be sure to remember not to plane over the edge when working off the end of the cover. Directions for rabbeting across the ends are given in Lesson XLIII. Do the work with a chisel, and be careful not to cut too deep in the middle.

With a gauge mark a line 1″ from the top of the box on the sides and ends; this is where the box and cover are to be cut apart. Fasten the box into a vise, with the jaws parallel and against the top and bottom, and with a fine saw cut down through one side, having the saw nearly parallel with the side you are at work upon. Be sure and have the saw vertical and only cut one side at a time. Turn the box over away from you, and continue to cut the other sides until the cover comes off; then carefully plane the cut surfaces just as little as possible, to get them smooth. Do not let the saw cut down into the further side, for then it is liable not to run straight. It is best to practise cutting crayon boxes in two until you are sure of doing a neat job, before beginning on this box.

Get a pair of ½″ hinges and shutting one of them together, take a trifle less than half its thickness with the gauge. Two inches from the ends of the box and cover, gauge very lightly outside and inside of the box and outside of the cover lines as long as the hinges are. The end of the

gauge-bar may be too long to allow of gauging the inside of the cover. With a pair of clamps fasten the box and cover together, with the cover wide open and the hinge surfaces parallel and even. Mark with a try-square just where the hinges are to come. Cut down with a saw and chisel to the gauge-marks on both box and cover. Remove the clamp, but clamp the box and cover together again with a piece of pasteboard between. Now screw on the hinges, making a small hole for the screws and being sure that the bolt of the hinge is *exactly* over the crack between the box and cover. Put only one screw in each side of each hinge, and then try and see if the box shuts evenly on all sides. If it does, put in the rest of the screws. If it does not, put in the other screws in such a way as to obviate the difficulty, first taking out the former screws and filling up the holes by driving a splinter in. The cover may be fastened by hooks bought at a hardware store or by a lock which must be set into the wood. Inspection of some work-box or writing-desk will show how this is to be done. If the box has been made of pine or some light wood it may be stained and varnished.

After varnishing, it may be rubbed down with pulverized pumice-stone and water on a piece of felt tacked on to a block convenient to hold in the fingers. This takes off the uneven surface of the varnish and makes an "oil finish."

Tests.—Is every corner square? Are the corner joints all perfect? Does the cover fit evenly? Does the cover shut closely? Is the whole surface smooth?

The last two lessons, of course, are applications of principles previously taught and will be used according to the time, taste, and ability of the pupil.

A great many other things may be constructed by the ingenious pupil, especially if he is pursuing the study of physics; and many pieces of simple apparatus can be made. Among the easier pieces of apparatus may be mentioned:

Equilibrium bodies—viz., a square, a triangle, and an oblong made of $\frac{1}{2}''$ stuff. These should have holes bored at the corners and middle to show centre of gravity and line of direction, and may be hung on a wire nail driven through a thin board fastened to a 6″ square base for a standard.

Blackburn's pendulum, directions for making and using of which may be found in Mayer's "Sound."

Levers to show static laws of the lever. These may have small screw-eyes put in at intervals, and for weights use sheets of lead 1″ square, with holes in one corner. The levers may be hung on a suitable frame.

Compound lever; wheel and axle; windlass; inclined plane; wedge-pulleys; wood hydrometers, weighted with lead and varnished; water-wheel; barometer-board; lifting-pump, argand-lamp chimney for barrel, and spools wound with candle wicking for the upper "box." A marble to drop into a hole in a cork at the lower end makes a good lower "box."

Telephones, microphones, and all sorts of electrical instruments may be made with a little skill and as much training as has been outlined in this little manual. For descriptions of simple home-made electrical apparatus, see Bottone's "Electrical Instrument Making."

Chapter V.

ABOUT TOOLS.

1. ALL schools usually must start manual training on as economical a basis as possible. It is therefore necessary that the teacher should be something of a mechanic himself: to have some knack with tools will greatly aid. A teacher of physics is generally qualified in this way.

To start with, have a carpenter build one good bench as a pattern for future ones; for the others a plank put upon "horses," with their ends against the wall of the room will answer. Among a dozen pupils there will always be found several who can soon be set at work; by following directions and the pattern, the other five benches may be made. The benches should have a vise at each end on opposite sides. The screws for these vises may be bought at the hardware store, and the jaws should be as long as the bench is tall, and be just even with the top of the bench.

TOOLS NEEDED.

2. Upon each bench or hanging near it should be the following tools (the usual cost is given for convenience):

1 14″ back-saw	$1 50
1 jack-plane	75
1 smoothing-plane	1 00
1 try-square, 6″ blade	25
1 set firmer socket-chisels, 1″, ½″, ¼″, ⅛″	1 05
1 claw-hammer	65
1 screw-driver	20
1 gauge	15
2 vises before mentioned	1 20
Material for bench	1 50
Total cost	$8 25

For every two benches there should be in addition:

1 26″ rip-saw	$2 00
1 26″ hand-saw	1 75
1 block-plane	1 00
1 shave	75
1 Bit-brace-light	35
1 oil-stone	25
1 set bits, ¾″, ½″, ⅜″, ¼″, ⅛″	1 25
1 knife, two blades	40
Total	$7 75

For every six benches there should be:

1 carpenter's square	$1 50
1 long jointer	1 50
1 pair match-planes	2 50
2 rabbets	1 50
1 grind-stone	3 00
Sundries, drills, bits, auger, scratch-awls, etc	5 00
Total	$15 00
Six times cost of each bench	49 50
Three times cost for each two benches	23 25
Total cost for class of 12	$87 70

Twelve pupils is all one man can conveniently instruct at once; if there are more, then another division should be formed.

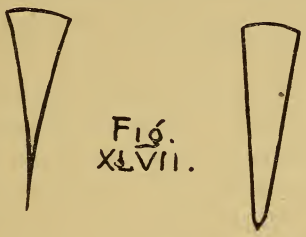
A very desirable thing is an anvil with vise attachment, $3.00, and a turning-lathe, the castings for which can be got for $5.00 and upwards; the frame can be made by the pupils. A glue-pot is desirable, but one can be made with a tin can inside of another.

The above is an estimate of what is desirable to have for a class of twelve, but many teachers will be obliged to get along with less than the above; it will be found that much can be done with possibly two thirds of the above list. It is generally agreed that instruction should take the form of class work partly, and this be followed by personal direction, supervision, and inspection. One lesson once in ten days or two weeks is a good proportion for class work.

SHARPENING TOOLS.

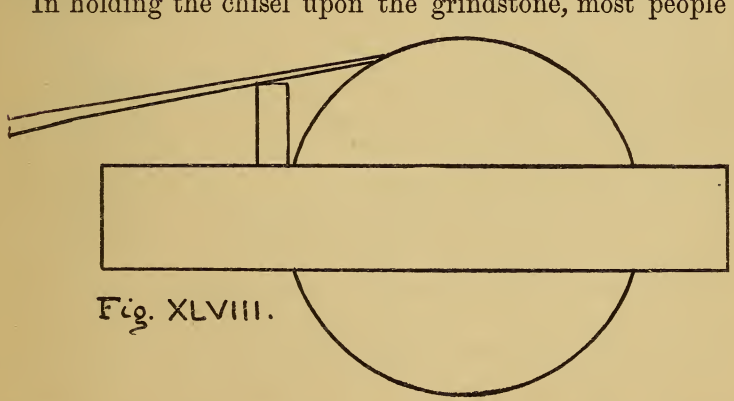
3. The apprentice is not allowed for a long time to sharpen tools or even to touch the grindstone except to turn it. Yet this is so important that the pupil must early learn to keep his tools in good condition. The best way at first seems to be to have the tools sharpened by a skilful mechanic; gradually let the pupils try their hands at the simple ones, as narrow chisels, as they become dull. The pupil must be taught the theory of the cutting-tool, the wedge, and he should be shown the angle at which different kinds of tools are sharpened. The difference between the proper edge of a razor and a wood-working tool, as a knife, must be shown; the former has a straight

bevel (it is sometimes concave), and the latter is first ground to a straight bevel and then rubbed on an oil-stone to make a short bevel, as shown in Fig. 47. Care must be



taken in grinding and whetting not to wear off the corners. The aim must be to keep the tools square across the edge. If the knife were sharpened like the razor it would run into the wood and also the edge would turn over.

In holding the chisel upon the grindstone, most people



desire a guide to keep the bevel at the same angle. For first-class work the chisel is held rigidly in a clamp, which allows it to be moved from side to side across the face of

the stone, but not back and forth. Ordinary shops are not fitted with grindstones having such attachments. In grinding, it is customary to have a rest for the chisel, which is held from moving backwards by pressing the fingers which hold it against the front of the rest. (See Fig. 48.)

In using the oil-stone, care should be taken not to rock the chisel nor to make a bevel on the flat side. In sharpening gouges or curved tools, care must be taken to move the tool across the face of the stone in order not to make grooves in the face of the stone. In grinding all tools except those with a very blunt edge, as cold chisels, the stone should be turned towards the edge to avoid a *wire* edge, which even then will sometimes appear and must be removed by drawing the edge across a piece of wood parallel with the direction of the edge. (Fig. 49.)

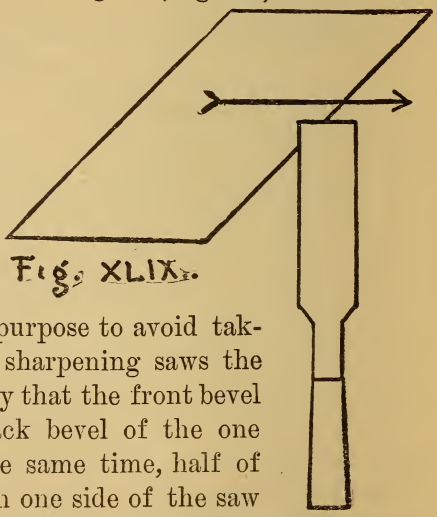


Fig. XLIX.

4. To file saws, they are held near their teet hin an iron clamp. The teeth should first be breasted down by drawing a flat file lightly over their ends until they are all of a length. An old file is generally used for this purpose to avoid taking off too much. In sharpening saws the file is held in such a way that the front bevel of one tooth and the back bevel of the one before it are filed at the same time, half of the filing being done on one side of the saw and half on the other. When the file makes the least pos-

sible noise, it is being held in the right position. The file should cut most on the back of the tooth. Saws with coarse teeth and saws for soft wood need to be set before filing. There are various kinds of sets, but the best is something like a pair of pincers, and can be adjusted to set fine or coarse. After the saw is set and filed it is sometimes "breasted" on each side in order to remove the slight inequalities of the teeth. Examination and comparison of the bevels on the teeth of splitting and cutting-off saws will show that they are filed by holding the file somewhat differently.

The teeth of the rip-saw are longer and the front edge is more nearly perpendicular to the length of the blade, and they have but little bevel.

Use of Tools.

SAWS.

5. The *rip-saw* is used to split pieces lengthwise, and the piece is laid over two "horses," the end at which the sawing is to be done projecting over beyond the horse. The workman stands on the left side of the piece and puts his right knee on the board just back of the front horse. The thumb of the left hand should be put down to the mark to guide the saw in starting. The saw should be held at an angle of about 45° with the length of the board, and care must be exercised to keep it perpendicular with the width of the board. Slow, long strokes must be used, not bearing down on the saw, but rather holding it up a little at the start, the first stroke being a drawing instead of a pushing

stroke. As the saw gets along, the front horse may be moved backwards or the board pushed ahead to prevent sawing the horse, until too much of the board hangs over in front, when the front horse may be moved up in front and the saw go down between the two horses.

To finish sawing, the last end of the board may be moved over the end of the back horse to let the saw go by and not cut the horse. If the board springs together and pinches the saw it is customary to thrust a wedge or screw-driver blade into the channel or kerf made by the saw.

Sometimes it is convenient to saw the board half-way and then begin at the other end; it will then be observed that in sawing from the butt to the tip of a tree the channel opens, but in sawing the other way it pinches.

Small pieces are held in the vise where the rip-saw is employed.

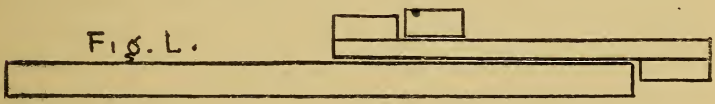
The *cutting-off saw* is used with large pieces on the horses, or with small pieces on the bench, in the manner to be described with the back-saw. In cutting off a long piece the left hand should be put around in front of the right and grasp the piece about to fall before it is ready to drop, or it will split off a bad piece. After this has been neglected once, the caution will be better understood.

The *back-saw* is for fine sawing, having, as its name implies, a back to stiffen it, because the blade is so thin. It is nearly always used with the work held in a vise or against a bench-hook or dog.

THE BENCH HOOK.—The pupil may make a bench hook (see Fig. 50) the first day by nailing cleats across the ends on opposite sides of a board a foot long and three inches wide. The edge of one cleat rests

against the front edge of the work-bench, and the work is pressed against the other cleat.

The work should be held firmly against the hook in such a position that the saw will just escape the right-hand edge of it; the thumb of the left hand should be placed down to the mark to guide the saw in starting; the further



end of the saw should be a little lower and start in first just to the right of the mark; long, slow strokes must be used, as before said, not bearing down on the saw. As the saw works down and gets to the edge of the block next the workman, the attention should be turned from the mark on top to the mark on the front edge, down which the saw must be carefully guided. When the piece is nearly off, ease up on the saw in order that the stick may not be split off.

For sawing off a stick it should always be marked on the top and front edge with a try-square, as will presently be explained.

Beginners are usually afraid to place the saw *against* the thumb, for fear of being cut; but examination will show that the sharp part of the teeth comes below the flesh of the thumb, and the saw cannot cut if the teeth are held against the thumb. If, however, the thumb is placed a little way from the saw, it is liable to slip, and then the thumb will be cut.

THE TRY-SQUARE.

6. The try-square (see Fig. 51), as its name implies, is to test work to see if it is square, and also for marking lines on narrow pieces, perpendicular to the edge. The blade is also used to test for flatness. For testing for squareness the handle or thick part is placed against one of the two surfaces to be tested, and the blade against the other, and then the work is held between the workman and the light to see if the surface under the blade is true, and square with the other surface. In marking with a try-square, care should be taken not to let the pressure of the marking instrument at the end of the blade move the handle away from the surface against which it rests, and so fail to get a perpendicular line.

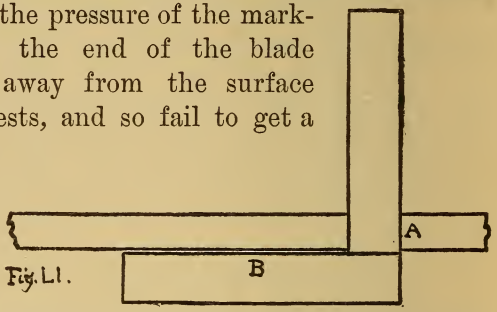


Fig. 51.

A sharp knife or pencil is to be drawn along the edge *A* and pressure applied with the left thumb at *B* to keep the handle down close to the wood. (Fig. 51.)

CHISELS.

7. Chisels are either heavy, called "framer," or light, called "firmer." The latter either have a tang to be inserted into a handle, or have a socket into which the handle

is driven. The socket firmer chisel is best adapted for the work here described. When used to smooth a surface it is held with the flat side next the surface to be smoothed, unless much material is to be removed, in which case it is used the other side up. The handle is grasped in the right hand and the blade with the left, often near the work to prevent the chisel slipping too far into the material. Instead of pushing the chisel straight ahead, it should be moved with a "drawing" stroke. (Fig. 52.)

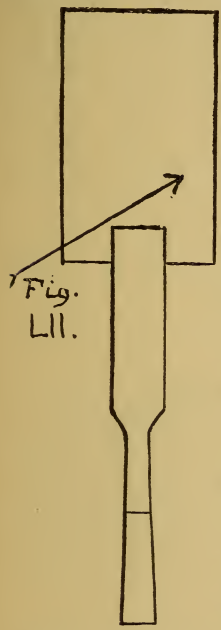


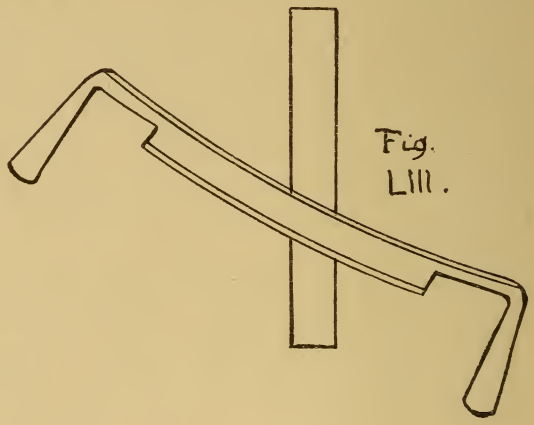
Fig. LII.

In this way it cuts easier and makes a smoother stroke. This kind of stroke is also used with a knife or shave. For cutting across the end and for digging out mortises a mallet is used to strike the end of the chisel handle. A short, thick spatula of hard wood makes a good substitute. Further directions for the use of chisels will be found in lessons requiring their use.

THE SHAVE.

8. The shave is a very wide, short chisel with two handles, and is pulled towards the operator instead of being pushed from him as is an ordinary chisel. It is used where considerable material is to be removed, as, for instance, from the edge of a board to straighten it or to make it narrower, when not enough to saw is to be taken

off. Except in the case of a concave curve it is always used with the flat side down next to the material, and should be held at some other angle than a right angle with the work, and a drawing stroke must be given, especially on hard wood. (See Fig. 53.)



PLANES.

9. A plane is a chisel held in position by a piece of wood or iron called the "stock," which keeps the chisel at the same angle, and by its under side, called the sole, prevents the chisel from going into the wood too far. The chisel, also called the "bit" of the plane, has a cap of iron on the upper side to turn over and break off the shavings, to prevent the wood from splintering when the plane is run against the grain. The common planes are the *fore-plane*, for the first planing of a rough board; the *jack-plane*, to follow this, having a broader chisel, with the edge straight instead of curved; the *smoothing-plane*, very short and

light, for quick strokes to finish the work; the *block-plane,* for the ends of pieces; the *long-jointer,* for making straight the edges of boards. There are also *rabbet-planes* to take away part of the thickness of an inch or less in width of a board, to make what is called a half-joint; and match-planes to make grooves and tongues to match boards together.

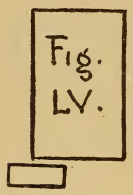
Besides these there is a great variety of moulding-planes, "hollows and rounds," patent ploughs, etc., for doing all kinds of fancy work.

USE OF PLANES.

10. In using a plane, stand with the right side to the bench, the left foot pointing forward, the right towards or under the bench, the right hand grasping the handle or stock of the plane if a small one, the left grasping over the top of the stock in front of the throat if a large one, or around the front end if a small one.

With a large plane put the thumb on the left side of the plane stock and the fingers on the right side; the body should be braced by the feet, to make a firm, quick stroke. The work is held in a vise if it is small, or against the bench-stop. Care must be exercised to hold down the front end or toe of the plane at the beginning of the stroke, and the heel at the end, otherwise the plane will stutter at the beginning and take off too thick a shaving at the end of the stroke. The plane should be started and be under headway before the chisel gets to the work, in order that the inertia of the plane and the operator's body may carry the plane along over the work. In draw-

ing back the plane over rough or hard boards it is customary to turn the plane on one edge, or lift up the heel, in order not to dull the chisel. With clean, and especially soft wood, it is easier to sharpen the chisel oftener, and not bother to raise it in drawing back. The *rabbet-plane* often has a movable piece called a *fence* on the sole, which can be adjusted to make the rabbet the right width (see Fig. 55). Sometimes there is no fence, or the rabbet is to be cut not at the edge of a board, and in that case the plane is guided by a cleat lightly nailed on to the work.



In using the *block-plane* across the grain, care must be exercised not to plane over the further edge of the board, for a piece will certainly split off. Plane towards the middle always, and with the chisel at an acute angle, so as to give a drawing stroke, otherwise the surface will be rough.

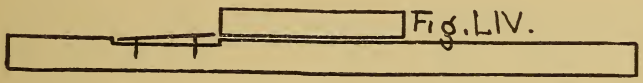
In using the *long jointer* to "shoot" the edge of a board, the board is fastened into the vise and the rear end propped up with a pin stuck through the front board of the bench. The left hand grasps the stock of the plane with the fingers underneath on the sole, serving to guide the plane on the board. The operator walks along in front of the board. The pupil should be shown how to set the plane iron in or out by striking the stock on the top or heel to draw the iron, and how to drive in the iron or move it to one side if one corner digs in too much. For this kind of work the ordinary plane that is set with a hammer is less troublesome than the patent ones which set with a screw or levers.

Planes should never be laid on the bench with the sole down, as it is liable to be scratched or the iron dulled.

NOTE.—A plane is said to be set "fine" when it takes off only a thin shaving, and "rank" when it cuts a thick shaving.

BENCH STOP.

11. One of the best and simplest bench-stops is made by taking a piece of strap-iron $\frac{1}{8}''$ thick, $1''$ wide, and $6''$ long. File one end sharp like a chisel, and then file notches with the edge of a flat file; two holes should be drilled in the iron $1''$ from each end and countersunk for screws. A groove is cut in the bench just deep enough to sink the iron in, and the back screw is put in tight, the piece of iron being bent a little to cause the front end to spring up. This front end is now adjusted as wanted by the front screw. Such a stop does not easily get out of repair. When a stick is to be planed its front end is driven up against the stop (see Fig. 54) hard enough so it



will not slip back when the plane is drawn back over it.

HAMMERS.

12. Hammers are classed as claw or piece. The claw-hammer is used for driving nails and drawing the same; the piece-hammer is used for riveting and for other work on metal. The piece is the chisel-shaped part at the back and may extend parallel with the handle, when it is called

straight, or it may extend at right angles, when it is called cross. It may also be spheroidal, when it is called a ball piece-hammer.

THE MALLET AND HATCHET.

13. The mallet and hatchet in their manner of using may be classed as hammers. Three movements are used in striking: the wrist movement, for light blows with a small hammer; the elbow movement, for ordinary blows; and the whole-arm movement, for very heavy blows. The pupil should practise striking the smooth surface of a board till he can make a dent of uniform depth all around. Then he should drive nails through a board a little thinner than the length of the nails, being careful not to leave any marks on the boards with the hammer; afterwards these nails should be driven back and drawn with the hammer. In drawing nails care must be used to put a block under the head of the hammer, that the nail may not be bent or the handle strained in drawing large nails.

14. Practice in scoring and splitting with a hatchet may follow. The different kinds of nails should be shown and the way to drive nails to prevent splitting. Brads and finish nails should be shown and the process of setting in the heads, also the clinching of nails, blind-nailing, toe-nailing, etc.

BITS AND DRILLS.

15. Probably no other simple tool has passed through such a complete evolution as the boring tool. From the simple brad-awl which makes a hole by pushing aside the

fibres of the wood, or oftener by splitting, to the expansive bit which bores holes from five eighths of an inch to three inches in diameter, the whole way is filled with different boring tools adapted for every different kind of work.

Boring tools may be divided into three classes—those which remove none of the wood, those which remove part of the wood, and those which remove all. Those which remove none of the wood are the brad-awl and pod or quill bit. The brad-awl is used in soft wood, whose fibres easily move aside to allow the awl to enter. If the awl is put with the edge across the grain it will cut the fibres without splitting. Sometimes the awl is driven in with the hammer and sometimes pushed with the hand with a twisting motion. The pod or quill bit cuts the fibres but does not remove the chips, which must be removed by drawing out the bit occasionally. Of the second class, which removes a part of the chips, are the various forms of gimlets, twist-drills, etc.

The gimlet has a screw-point which draws it into the wood; this screw-point is liable to split hard and thin woods, and must be used with caution; also, the gimlet must be removed once in a while to withdraw the chips, and at best the gimlet is a slow-working tool. The twist-drill is, all things considered, one of the most valuable boring tools; especially the small sizes, which fit into a drill-stock. Being all the way of the same size, the hardest and most fissile woods can be bored without splitting. The ordinary auger-bit is probably the most used of any boring tool. The pupil should learn how to put it into a brace, how to hold the brace, how to put the work into the vise to

prevent splitting, and cautioned to put a block behind the piece he is boring to prevent splintering when the bit comes through.

A very useful tool for screw-holes is a short pod-bit with an enlargement, called a countersink, for making the cup-shaped cavity for the head of a screw. This tool obviates the necessity of changing from a bit to a countersink in boring for screws. A little instruction in this connection may be given in regard to drilling and reaming metals, as the ability to do this is often useful in making simple apparatus. The expansion-bit will be found a valuable tool, as with it holes may be made of different sizes, and many pieces of apparatus may be made if such a tool is at hand.

THE SCREW-DRIVER.

16. The screw-driver should be held in a line with the screw, and the end that fits into the slot in the screw should not taper much, for then it will slip out of the slot when the screw turns hard. Practice should enable the pupil to keep the driver on the screw, allowing the end of the handle to turn in the palm of the hand, while with a wrist movement he turns the hand back to get a new hold on the handle far enough around to give the driver one half a turn. Be sure and work at this until you are able to turn in a screw without taking the point of the screw-driver out of the slot or allowing it to slip out.

THE GAUGE.

17. The gauge is used to draw a line parallel with the edge of a stick, called the working face, and the head is set

at the proper distance from the spur and held in place with a thumb-screw. Gauges with two bars should be used, so that they will not have to be changed in marking out a mortise-and-tenon joint. The gauge is held in the right hand and either pushed or drawn, care being exercised to have the head rest closely against the side of the stick. Also, the gauge should be turned so that the spur only makes a slight mark at first. It may then be drawn over the work again. The gauge should run on the bar as its support, and not on the spur. It is often best, especially for beginners, to put the work in the vise and hold the gauge with both hands, not for the purpose of making a heavy mark, but for the purpose of making a light one. A cleat may be nailed one inch from the right-hand end of the bench, running across the end, against which the piece is held while being gauged. As a pencil is never held upright to draw a line, so do not move the gauge along with the spur at right angles to the direction of motion, but turn the gauge so that the point will be drawn along and make a smooth line. That face against which the head of the gauge rests is gauged *from;* the one on which the line is drawn is gauged *on.*

THE KNIFE.

18. The knife for the use required should be a large two-bladed knife.

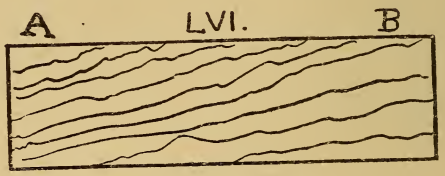
THE T-BEVEL.

19. This tool is used like a try-square to draw lines across the surface of a piece, but not at right angles to the adjacent surface (Fig. 57). The blade may be set and held in place by the thumb-screw.

GRAIN OF WOOD.

20. A piece of wood, if soaked and pounded, will be found to be made up of fibres. The direction and character of these fibres constitute the grain of the wood: if the fibres run straight, the wood is straight-grained; if crooked, it is cross-grained; if the fibres are fine, the wood is fine-grained, etc.

Various peculiar appearances due to the annual growth of the trees give rise to the terms silver grain, curled grain, bird's-eye, etc. Silver grain is due to a special layer of cells or fibres, which are found by sawing the wood on radial lines, *i.e.*, from centre to circumference; on this account such lumber is called "quartered," as quartered oak, which is made by splitting the log into four parts and then sawing the boards from these quarters. Fibres of wood separate more easily lengthwise than across.



The above figure (Fig. 56) represents a piece in which the grain runs down into the wood from *B* to *A*. In planing such a piece in the direction *BA* the plane iron would have a tendency to run in, and as soon as the sole of the plane stopped it the shaving would break off, leaving the surface rough. Planing in this direction is called "working against the grain," while working from *A* to *B* is with

the grain and leaves the surface smooth. The cap of the plane is to prevent its running in in such timber. Whenever it is possible lumber should be worked with the grain.

SAND-PAPER.

19. Sand-paper of various degrees of fineness may be obtained from No. 0 to No. 1½. To use, it is wrapped around a block of wood convenient to hold in the hand. This is then rubbed on the piece to be smoothed. Use the coarse first and finish with the fine. Sometimes a piece of wood is sand-papered and then its surface dampened. After standing until it is thoroughly dry the fibres which the dampening raised up may be polished off.

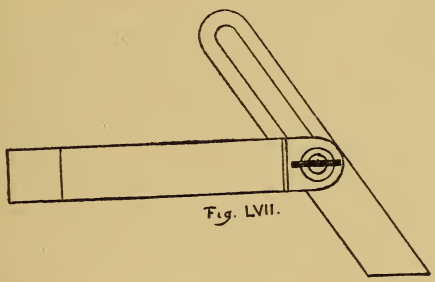


Fig. LVII.

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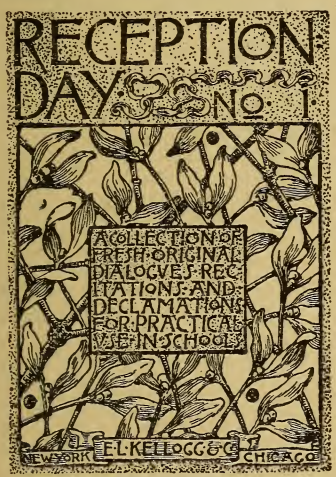

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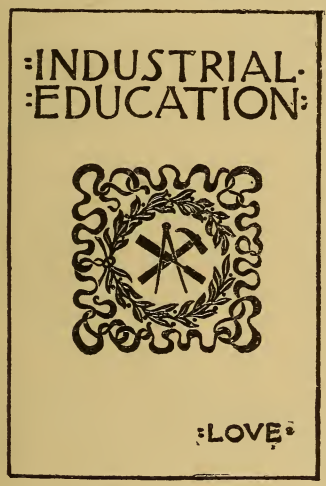

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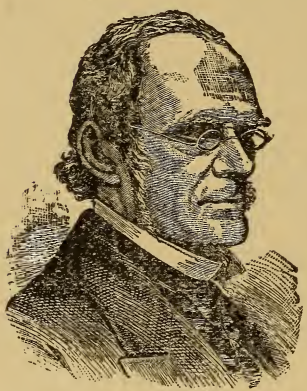

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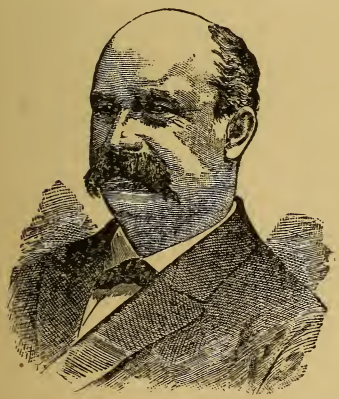
Notes of "Talks on Teaching" given by COL. FRANCIS W. PARKER (formerly Superintendent of schools of Quincy, Mass.), before the Martha's Vineyard Institute, Summer of 1882. Reported by LELIA E. PATRIDGE. Square 16mo, 5x6 1-2 inches, 192 pp., *laid* paper, English cloth. Price, $1.25 ; *to teachers*, $1.00 ; by mail, 9 cents extra.

The methods of teaching employed in the schools of Quincy, Mass., were seen to be the methods of nature. As they were copied and explained, they awoke a great desire on the part of those who could not visit the schools to know the underlying principles. In other words, Colonel Parker was asked to explain *why* he had his teachers teach thus. In the summer of 1882, in response to requests, Colonel Parker gave a course of lectures before the Martha's Vineyard Institute, and these were reported by Miss Patridge, and published in this book.



The book became famous ; more copies were sold of it in the same time than of any other educational book whatever. The daily papers, which usually pass by such books with a mere mention, devoted columns to reviews of it.

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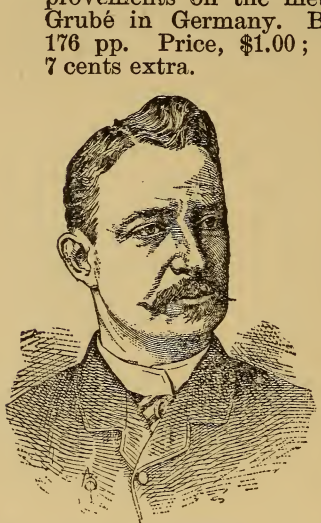

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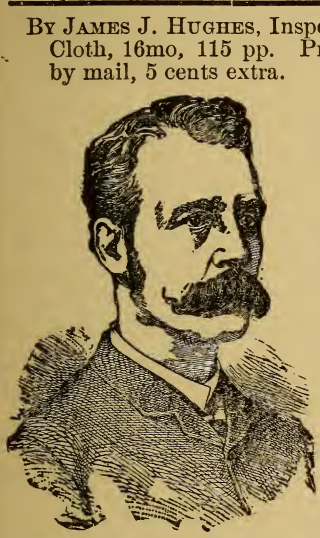

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